CHEMICAL & METALLURGICAL ENGINEERING

APRIL, 1942

PUSHING PRODUCTION FOR DESTRUCTION

From cannon blender to packing house goes this load of smokeless powder en route to the battlefronts of the Democracies. Typical methods of manufacturing this No. 1 chemical munition are described in feature article and pictured flow-sheet on pp. 76-79 and 110-113.

SOLVENT-PROOF SYNTHETIC REPLACES RUBBER

Tubing and flat sheets of Resisto-flex, one of the newer synthetic rubber-like plastics, have many industrial applications. Essentially a mixture of polyvinyl alcohol and acetate, to which various compounding agents have been added, this material is proof against most organic solvents. See pp. 80-81 for illustrated article.

STAINLESS STEEL LOOKS TO THE FUTURE

During and directly after the last war chemical industry pioneered in developing new applications for this most valuable material of construction. That we can expect still greater progress is seen in the first of two discussions of the metallurgical problems of chemical engineering. See pp. 88-91.

WASHINGTON NEWS pp. 118-119

HEAT TRANSFER TAKES PLACE IN SECONDS

CONTINUOUS, RAPID FLOW OF PRODUCT

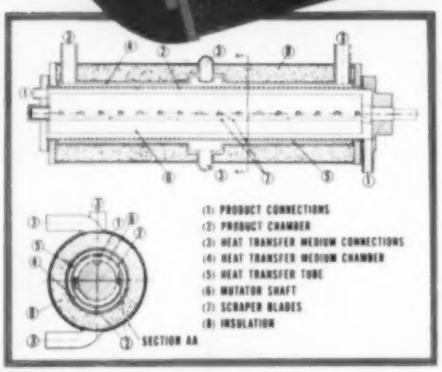
UNIFORM TEMPERATURE ACCURATELY CONTROLLED

FULLY CLOSED SYSTEM

SIMULTANEOUS MIXING, EMULSIFYING OR AERATING

MORE ECONOMICAL

A New Heat Transfer Unit for Liquids and Viscous Materials Offers 6 Big Advantages!



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CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902

NEXT MONTH

In the past few years much attention has been given to the diffusional aspects of certain unit operations. This approach often supplies valuable information concerning rates at which operations can be completed. Next month's 48-page *Chem. & Met.* report will discuss the unit operations of this group from the standpoints of theory, practice and equipment. Particularly will it seek to interpret and correlate the newer material in a way to be most useful to busy chemical engineers.

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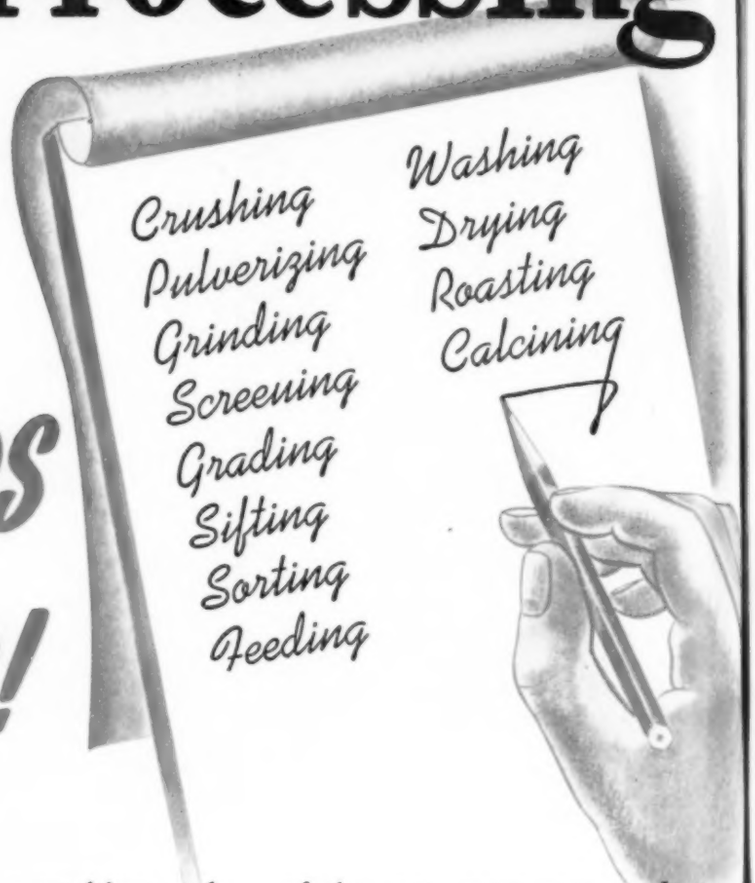

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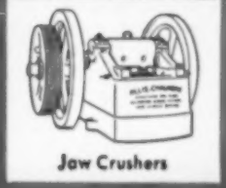
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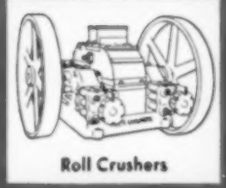
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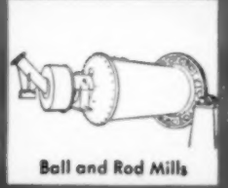
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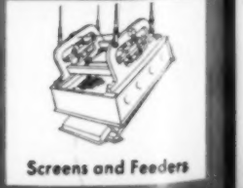
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CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902 S. D. KIRKPATRICK, *Editor*

APRIL, 1942

"Because, Too Little and Too Late....."

PRESIDENT HOTCHKISS of Rensselaer Polytechnic Institute is a careful student as well as a great admirer of Rudyard Kipling. When certain munition plants were closing down for certain February birthdays, he went to his library and dug up these famous lines of Britain's militant poet:

EPITAPH, 1918

The battery's out of ammunition, sir!
If any mourn us at the shop, say
"We died because the shift kept holiday."

As we move still further into our own war program, the great problem that is obvious to us all is the need to speed production—to rid our war machine, once and for all, of the deplorable and damnable slowdowns that are sometimes costing us 10 or 20 or even 50 percent of vital output. So Dr. Hotchkiss, with his mind on Bataan and Batavia, followed Mr. Kipling's lead with these stirring words:

EPITAPH, 1942

For lack of ships and planes and tanks
We lie here where we fought, in serried ranks,
Because, too little and too late,
The shift made six instead of eight.

That, perhaps, is negative psychology and therefore contrasts unfavorably with the positive fighting slogans of Don Nelson's lieutenants in the War Production drive. Yet to some of us nothing brings the war home so quickly as the casualty lists and the uncolored reports of valiant fighting against enemies that are not only numerically superior but better equipped and better supported by air and naval forces.

Gradually the people of this country, led by the parents and relatives of the boys already in the Army and Navy, are getting mad. They are in no mood to trifle with those who offer excuses for something less than "all-out" production. They are getting tired of congressional wranglings over wages and hours, of labor and management bickering over "union security" agreements, of political persecutions of American industrialists whose only fault has been that they have been too busy with war work to waste time fighting in the courts for their own defense. The time has come for a showdown with anybody and everybody who is not proving by his every activity that from now on war production comes first!

The job to be done is not in Washington, even though we look there for better leadership. "The war will be won," said Lloyd George in 1917, "in the workshops and laboratories of industry." That is even more true today in this country than it was in England then. We've got to produce ships and tanks and planes at higher rates and in better quality than any other nation or group of nations in history. We've also got to have more powder and ammunition and better weapons.

This is the first and most pressing challenge that our chemical industries must meet. Nothing can be permitted to interfere with building, equipping, manning and operating the many new plants needed to make munitions. But of almost equal importance is the need for literally hundreds of critical chemicals and strategic metals that are essential some place in the war program. It is in these plants that chemical engineers will find their best chance to help in speeding production. Obviously this can seldom be done by putting on more shifts or utilizing idle equipment, because we are already approaching our limits there. But there are many places, we suspect, where yields can be increased or quality improved by intensive application of engineering knowledge and methods. A few good men with no other jobs than to smooth out the wrinkles, eliminate lost motion and waste effort, will more than earn their pay in most plants. Our biggest new supply of essential raw materials is through better utilization of what we

are now wasting. No one knows this better than the chemical engineer who is really on his job. No one can help management more in making the most of what we've got.

We, the men who man America's workshops and laboratories, must make certain *now* that the epitaphs which will be written on American graves in far-away countries won't say that death came "Because, too little and too late, the shift made six instead of eight!"

INDUSTRIAL AMERICANIZATION

On Feb. 16, 1942, the Secretary of the Treasury, under an executive order signed by the President of the United States, took title to approximately 97 percent of the stock of the German-owned General Aniline & Film Corp. Early in March four widely known American engineers and executives were named by the Treasury as a managing board to direct the affairs of the corporation and to operate it as an American company. One of their number, Robert E. McConnell, mining engineer, chairman of the Engineers Defense Board and former OPM official, was elected president and chairman of this managing board which consisted of Albert E. Marshall, president of Rumford Chemical Works, George M. Moffett, chairman of the board of Corn Products Refining Co., and Robert E. Wilson, President of Pan American Petroleum & Transport Co. and former petroleum consultant to OPM. Subsequently Mr. McConnell announced the appointment of three operating executives: Mr. Marshall to serve as first vice president; Joseph S. Bates, president of the Bates Chemical Co. of Philadelphia, to be vice president in charge of production, and Dr. William F. Zimmerli, former European technical director of the du Pont Company, to serve as vice president in charge of research and patents.

Thus the decks are cleared for an experience in Americanization which will be watched with absorbing interest for a number of different reasons. In the first place, genuine American control is of greatest strategic importance because this $67,000,000 offspring of the I. G. Farbenindustrie A. G. owned many patents, covering inventions that are essential to modern warfare as well as to peacetime progress of the pharmaceutical, dyestuff, chemical and photographic industries. Hence it is essential that these resources be rid completely of German control and influence in order that they may serve American war needs.

A second reason that this move is so significant lies in the fact that it is the first time the U. S. Government has taken over an alien industrial property and tried to operate it as a going enterprise. This is in marked contrast with the practices of the Alien Property Custodian in the last war. We are assured by the directors and the Treasury Department that this is not to be a yardstick to measure government vs. private operation, but it may well serve as a model for handling other foreign properties whose funds now frozen in the Treasury Department will aggregate approximately $7,000,000,000.

Finally there is no dodging the fact that this particular property is a "blue chip" in the inevitable poker game at the peace table when this war is over. Germany used it to play for pretty big stakes—as the American link in a projected chain to control world organization of chemical industry. Uncle Sam will remember that when the time comes. Meanwhile he has put the property in the capable hands of honest, technically trained Americans whose sole purpose will be to conserve its resources for the public good.

ARNOLD, RUBBER, WAR AND TREASON

Most heartening of all the news to come from Washington this month is the announcement that the trust-busting activities of Thurman Arnold are to be postponed for the duration of the war,—that is, wherever either the Secretary of War or Navy feels that the prosecution would delay the war effort. Had this agreement come two years ago, we would have had more aluminum, magnesium, potash and ammonia with which to fight this war. Likewise, in our opinion, we would have had more synthetic rubber despite the charges made in the vitrolic attack on the Standard Oil Company (N. J.) by this same zealous crusader when he appeared before the Truman Committee of the Senate.

It is quite significant, we believe, that the moratorium on trust-busting was disclosed at the end of the same week in which Mr. Arnold had used the Senate investigation as a sounding board for broadcasting the same sensational charges which he had just withdrawn from an anti-trust suit against the company in order to obtain a consent decree. Thus he got what he probably wanted most—publicity for his contentions while more or less effectively spiking the guns of those who now have no chance to have their defense heard before an impartial tribunal.

Chem. & Met. readers who have followed the course of the many technical developments that have resulted from the Jersey company's original relations with the German I. G. know that the United States has benefitted greatly from these international exchanges of technology. Likewise, most of us have a pretty good idea about the character and motives of the chemists, engineers and executives who have figured so prominently in the stream of inventions that has flowed out of the original transaction for the hydrogenation patents. To insinuate that these men were disloyal to the United States or as Senator Truman put it, guilty of "treason" to their own government, is an insult which we can join Mr. Farish in condemning with "indignation and resentment."

Unfortunately, the whole synthetic rubber picture is so complicated with accusations and denials, charges and counter-charges, that the American

public is ready to believe almost anything. It is looking for a scapegoat and where could a better one be found than in our largest corporation which for a dozen years has been dealing not only with the Germans but also with the Italians and the Japanese? That these relations were well known to everybody—some of them actually carried on at the insistence of our State Department—all means nothing now that the witch hunt is on in earnest. But it is probably bringing some snickers and perhaps some sneers for democracy from Berlin and the "Big House" of the I. G. at Frankfort-am-Main. Strangely enough, when Germany decided to fight a total war involving an all-out mobilization of her technological and industrial resources, she did not start by pillaging the executives of I. G. Farben who could contribute most to her war effort. That would have been sabotage and real treason over there. Here it is social reform, political capital and personal publicity.

WASHINGTON HIGHLIGHTS

PRIORITIES mean little any more unless they are very high in the *A* series. So many people have been given some sort of a priority rating that the goods actually available cannot go very far down the list. This Spring it appears that anyone with less than a A-1-j priority can get no copper at all. Thus the program of replacing priorities with allocations builds up more and more momentum. Anyone who must have something in order to do business for Uncle Sam must see to it that he gets a definite allocation of the required materials, whether they be war materials or materials of construction. It is no longer safe merely to have a priority rating.

SPEED, NOT COST, is the primary criterion for an award to bidders who compete for business on war contracts. Under the plan of negotiated contracts, a preference is also given to small firms over big ones since the smaller firms can usually handle simpler jobs and the big firms are reserved for more complicated and difficult assignments. Where new construction is required before manufacture of needed goods can begin, the bidder has preference who imposes a minimum requirement for scarce machinery, equipment and materials of construction. All these considerations show how far Uncle Sam has varied his buying practices to meet wartime conditions.

CONTAINER SHORTAGES seem likely to develop. Bottles, jars and other glass containers, as well as tin cans and metal packaging material, are affected. For a time it appeared that the glass shortage might be due to limited supplies of soda ash. Now it is evident that two other factors will have a much earlier and more serious influence. Rubber, cork and other very scarce materials for closure gaskets are going to be severely restricted. In fact these materials may be prohibited for many types of goods. Only a little less imminent is the restriction on the use of metals for closures. Although the problem of getting metals is going to be difficult no matter what container is ordered, extensive re-use is being urged on every division of industry.

SECRECY in industry disappears as military secrecy increases. Process industries will be disturbed to note two possibilities that may result from over-zealous administration of Federal regulations. Under the guise of proving that a corporation is entitled to an explosive license, the lawyers of the Department of the Interior may pry into minute detail of your company's stock ownership. The effect appears like malicious meddling but may have to be tolerated. Little less objectionable is the recent authorization by Presidential order that the Office of Price Administration may inspect corporation tax rates in the form of transcripts. There is nothing to indicate that this does not lay open much of the confidential information of corporations to unfriendly scrutiny.

FREEZING OF LABOR RELATIONSHIPS seems to be one answer to the slow-down problem. So long as the labor situation is subject to jurisdictional disputes, possible changes in working conditions and wages, the worker is distracted from his main job of all-out production. Meanwhile management is constantly plagued with demands that must soon be answered, once and for all.

INVENTORIES have been rising despite shortages of raw materials. Balance sheets for 15 leading chemical companies for 1941 reported inventories of $300,068,000 compared with $248,382,000 in 1940—up about 20 percent. For industry as a whole the rise is estimated at more than a third of last year's stocks.

CHEMICAL PRODUCTION GOALS rise constantly. With military demands as now anticipated, it is almost unbelievable that there will be surpluses of any important chemicals no matter how hard the industry may work on expanding production schedules. Temporary exceptions to this rule are expected, as, for example, instances where it is difficult to find storage space at the point of production because of delays in shipping instructions or facilities. But the overall demand for war chemicals seems insatiable.

STORAGE FACILITIES in many chemical plants will be strained to the limit. Under current impending increases of demand, irregularities in transportation make it necessary that every management plan for maximum possible storage space for incoming raw materials, partly finished goods in process and finished products. No one can foretell the emergency that may increase the need for any or all of these facilities. Wise executives and engineers will have their plans well laid.

PRICES, in the opinion of some Washington observers, are now getting out of hand. The situation is described as "dangerously explosive." Inflation in national income to the extent of at least 20 billion dollars in 1942 is almost certain.

RESEARCH LABORATORIES, as well as control laboratories, using certain specified chemicals defined as "ingredients of explosives" must have licenses before they can buy or use such materials. Responsible persons in charge of these materials must keep a careful record of use or disposition. Theft or loss must be promptly reported or serious penalty may follow if diverted materials are used for sabotage. All of the technicalities of wartime are involved in this set of rigid and restrictive rules.

Producing Smokeless Powder By 1942 Methods

R. E. HARDY *Colonel, U. S. Army*

***Chem. & Met.* INTERPRETATION**

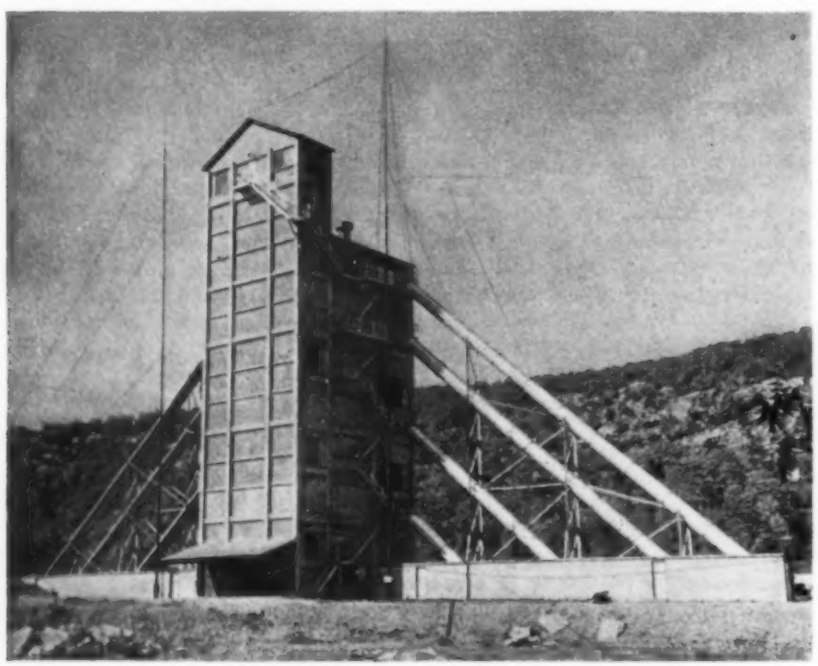
This article and the pictorial flowsheet on pages 110-113 describing operations in one of the new smokeless powder plants it is hoped will serve the useful purpose of instructing new operators in this and similar plants in the operations with which they will be concerned. Also this information should be of assistance to raw material and equipment supplies of these plants and those still to be built.— ***Editors.***

ONE OF THE world's greatest war machines for the production of combat equipment is being built by the Ordnance Department of the U. S. Army. This multi-billion dollar program, which is already partly completed, consists of numerous department-owned factories for the manufacture of rifles, machine guns, cannon, tanks, bombs, shells, ammunition, gunpowder, ammonium nitrate, picric and other acids, toluene, etc.

Created shortly after the Revolutionary War, the Ordnance Department ever since has had the responsibility of designing, developing, manufacturing and procuring the war material used by the army, which includes 1,200 major items, 250,000 components. Startling innovations in the realm of munitions have constantly stemmed from the research and manufacturing arsenals of the Ordnance Department. Their influence on industry in general has been profound. Through their efforts America's combat materiel today is superior to that of any country in the world. Also under the guidance of the Ordnance Department, American factories are fast being converted to the production of these many war items.

Included in the department's building program are smokeless powder plants. Typical of these is a plant which covers an area of several thousand acres, and which cost in the neighborhood of $100,000,000. Several hundred buildings with a combined floor space of more than 2,000,000 sq. ft. were erected. It was necessary to build 50 miles of automobile roads and lay 67.5 miles of standard gage railroad track within this area. Service piping, including steam, water, brine, fire and electric, totals 186 miles, and for sewage and additional 27.5 miles. There are 15 miles of wire fencing.

Cannon powder blending house equipped with drop hoppers. When the trap door of a filled hopper is pulled, powder drops onto an inverted umbrella-shaped baffle



The water supply is not taken from a river. To avoid the necessity for filtration, wells were sunk through approximately 90 ft. of sand and gravel close to the shore of the river. These are of the Ranney water collector type. Motor-driven pumps will supply approximately 50,000 g.p.m. The water is pumped into two reservoirs, each of immense capacity.

Adjoining the two reservoirs are two steam-electric plants. Considerable distance separates each power plant and reservoir from the other power plant and reservoir. An electric transmission line in the form of a loop connects the two power units so that in case one fails current can be sent from the other to the affected areas.

The 11 kv. distribution loop has 5.3 miles of pole line with 54 steel transmission towers. Current at 2,300 volts is distributed through 39 miles of pole lines. In addition there are 46.4 miles of pole lines for road and fence lighting. The telephone and fire alarm systems utilize 25 miles of cable.

The base of smokeless powder is nitrocellulose, made by nitrating cel-

lulose. Wood or cotton can be used as the source of cellulose, but as wood contains lignin, which must be eliminated, cotton is employed at this plant as the source for cellulose. Cotton linters are used, since long staple cotton balls up and plugs slurry lines and valves. If the supply of linters should run low, it can be replaced with long staple cotton which has been chopped up. Oils and other impurities in the cotton are removed with a sodium hydroxide treatment and the cotton is then washed free of alkali and bleached. Cotton received is already processed to this stage. The first treatment given it here reduces the external moisture. Since the heat of dilution of sulphuric acid by this moisture would be considerable with subsequent danger of fires during nitrating, drying is imperative. This is accomplished in a long continuous conveyorized oven heated by radiation with steam pipes, the cotton being fluffed out of the solid bales at the entrance.

Military nitrocellulose is composed of a mixture of high-grade nitrocellulose and pyro-nitrocellulose. The first of these contains an excess of nitrogen and contributes ease of ignition and high potential characteristics, the latter contains a small amount of nitrogen and acts as the vehicle for the insoluble variety (the high-grade type is insoluble in ether-alcohol).

In the nitrating process the cotton, after being weighed into fiber cans, is sent by conveyor to the third floor of the nitrating houses where there are several groups of charging hoppers these supply the dipping pots suspended below the floor. Four pots are included in one nitrating unit. Cotton and nitrating acids are charged into the dipping pots. Beneath these pots and on the second floor are several wringers, one serving each of four dipping pots. Suspended under the wringers are immersion basins serviced with water. The four pots, wringer, and one immersion basin make a complete nitrating unit. In operation the pots are dipped in their order, properly timed so that by the time the fourth pot is dipped, the first charge is ready to be dropped into the wringer. Nitrocellulose is discharged from the wringer into the immersion basin. drowned with water, and flushed into slurry tanks.

A system of collecting pipes from the dipping pots conducts acid fumes to a cyclone where the nitric acid is dissolved in water for concentration and reuse.

Impurities remain to be washed out in the next building in the line. This operation is known as the boiling tub procedure or stabilization. With the cellulose is always some degraded or decomposed cellulose known as hydrocellulose or oxycellulose. As cellulose is treated with nitric acid, nitric esters of other substances are also obtained. There also accumulate sulphuric esters as a result of esterfication with sulphuric acid. The function of the boiling tub house is to remove these foreign ester impurities which are inherently unstable and unsatisfactory.

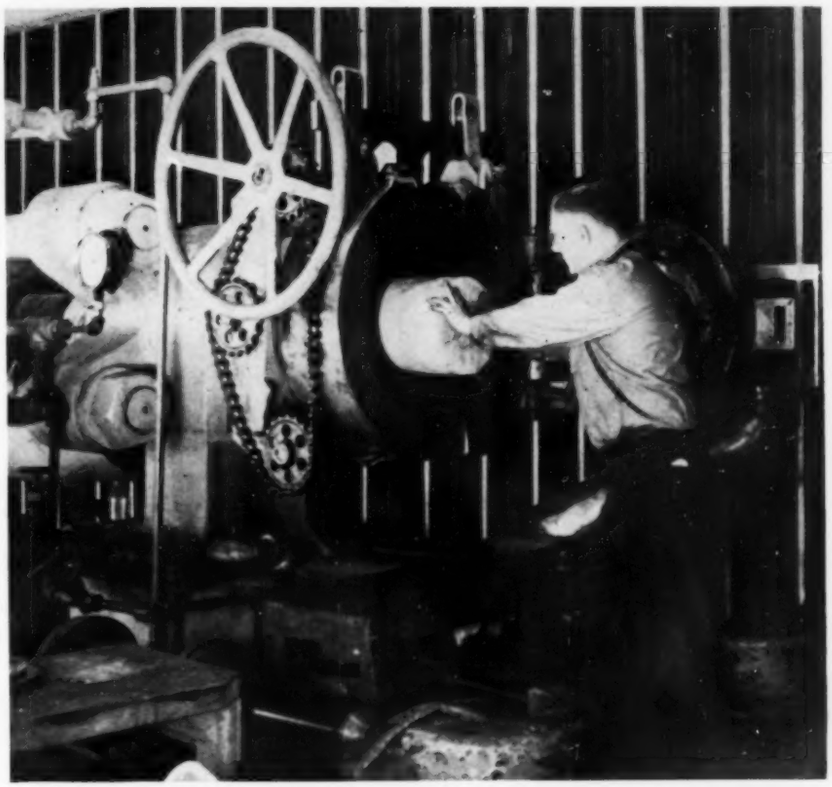
The slurry entering the boiling tubs contains a small amount of acid expressed as sulphuric. The acid is that resulting from the dilution of the acid left in the nitrocellulose after nitration. The acidic solution is pumped over to the boiling tub house where it is put into wooden tubs and heated indirectly with steam which is introduced under a false bottom.

After the boil is complete, the material is run out of the tubs and put into another intermediate slurry tank. Any free acid is neutralized with sodium carbonate, but the nitrocellulose must be broken up to get at the acid held between the micelle and fibrils of the fibers. This is accomplished, together with preparation for colloiding, in the pulping house. The line is still divided into high-grade and pyro nitrocellulose.

To accomplish the pulping the alkaline slurry is passed through a series of three Jordan refiners and pumped to the poacher house. The final neutralization is accomplished here by the addition of more sodium carbonate. Heat and agitation insures the reaction between the acid and sodium carbonate. Boilings, settlings, decantations, and rewaterings follow, and the residual sodium carbonate and salts are removed by cold water washes. After each boiling and washing, the slurry is allowed to settle and at least 40 percent of volume must be decanted.

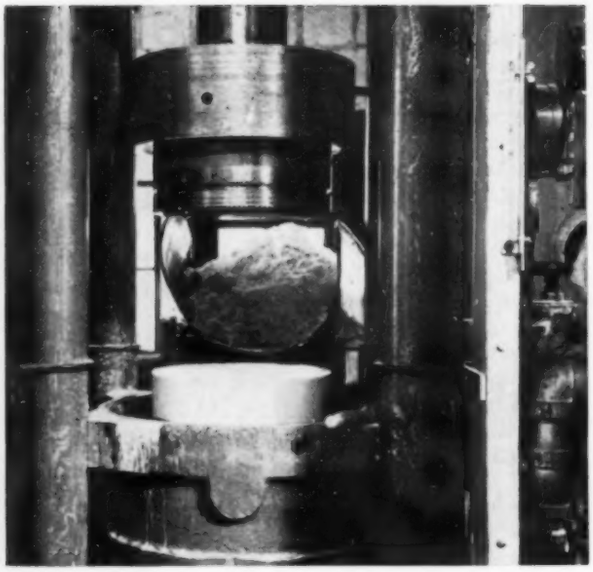
Each high-grade and pyro poacher charge is analyzed and then pumped to huge vats with umbrella baffles and agitators in the blending and wringer house, and blending produces the desired nitrogen content. After a sample of the blend has been approved by the laboratory, nitrocellulose is dewatered as much as possible before going to the dehydrating press. Centrifuging reduces moisture in pyrocotton to desired percent. The product is now held in transfer cars ready for the smokeless powder area.

Smokeless powder was the chief propellant during the World War,



Powder is first pressed into blocks so that it can be handled easily. It is being charged into a screening press by the operator

Strings or ropes of powder are cut into pieces of desired length and then loaded into cans for conveying



Block of nitrocellulose being ejected from dehydrating press. New charge appears above

but it had two serious defects which have been corrected since. First, moisture was absorbed by pyro powders; and second, the combustion products of the powder flashed (burned) at the muzzle. Deviation from ballistic standard was caused by moisture absorption by pyro powders used during the World War which were quite hygroscopic. Composition of du Pont "FNH" and "NH" powders permits adjustment of moisture to normal humidity at average temperature and because of composition, is much less hygroscopic than pyro powders.

Production lines in the smokeless powder area start with a dehydration press house. Here water present in the nitrocellulose is removed and alcohol is substituted. The nitrocellulose is charged into a hydraulic press and compressed by a low-pressure ram. Alcohol is forced in at the bottom of the press under a higher pressure, displacing the water. This process is aided by a partial vacuum applied through perforations in the ramhead.

The pressure exerted by this ram is then increased and some of the alcohol forced out of the cake. Enough alcohol is left in the block so that all alcohol requirements will be satisfied for the colloidizing action within the mixer house.

Actual colloidizing is accomplished in the mixer house where the dehydrated alcohol-containing blocks are charged into mixers. In a few minutes the action breaks up the blocks and partially mixes the nitrocellulose and insoluble compounding agents, and then ether containing a stabilizer and plasticizer is added. These ingredients act as plasticising agents and control the burning of the finished product, and thus aid in the elimination of flash. The ingredients used form a fairly complete colloid of the nitrocellulose and affect the hygroscopicity of the nitrocellulose to a much greater extent than would be expected from the percentage compositions. Thus the World War difficulty of absorption of water by pyro powders is eliminated. When powder decomposes, nitrogen-oxide fumes (NO_2) are given off which react with moisture to form nitric acid. The acid, in turn, catalyzes the decompositions of nitrocellulose. The stabilizer reacts with the NO_2 and removes it.

Material for cannon powder is mixed for a given time, and since rifle powder manufacture differs from this point, further discussion will deal only with cannon powder. The colloidal formation is completed in mixers of a slightly different type, known as macerators; then blocked in presses for convenience in handling.

The next building in line is the screening and graining house. Here the powder is put through screens in a press in order to remove lumps and impurities. This is called a macaroni press, as powder comes out in string or rope-like form. This powder is blocked once more and then sent to graining presses which extrude the powder through screens followed by a perforated die. Strings or ropes of powder so obtained are then sent to a cutter where powder grain lengths are regulated.

Removal of alcohol and ether is accomplished by distilling the solvent out of the grains with hot air and then passing the air through a condenser in order to remove the solvent. The powder is put into covered cars which are sent to the solvent recovery building. Here air heated by steam coils is passed through the cars and then partially by-passed through a condenser where much of the picked-up solvent is condensed. By-passed and unby-passed air is sent back over the coils for recirculation.

After passing through the dump shed house, the uniform powder is conveyed to the water-dry-house on a conveyor, or pumped by fast flowing water and put into storage tanks in the water-dry-house. Here the remaining solvent is removed. Water preheated by steam is pumped through the tanks so that the solvent may be quite rapidly dissolved out of the powder grains. A portion of the water in the tub is always thrown away with the differential amount of water being made up from a hot water tank within the water-dry-house. This procedure is followed until the residual solvent left in the powder grains has been decreased to a low percentage. After the powder has been in the water-dry-tanks for the required length of time, the removal of solvent is considered complete. The powder now contains water and small amounts of ether and alcohol, and the removal of that water is left to the so-called C. C. (control circulation) dry-house. Here the mass

is dumped into a bin and hot air, obtained by passing air over a steam coil, is passed through the powder for a sufficient length of time to bring the moisture content down to an average value to be expected under normal conditions of temperature and humidity. The powder is now finished as far as the actual manufacturing processes are concerned.

Blending is next in order, and blending towers with drop hoppers are provided for this purpose. When the trap door of a filled hopper is pulled, the powder drops onto an inverted umbrella-shaped baffle, is scattered, and collected in another hopper. This procedure is carried out until a good blend is obtained. The powder is then sent to the packing houses, weighed into containers, which are then sealed, air-tested, stenciled, and routed to the shipping and storage houses.

Rifle powder manufacture differs in that the powder is coated with various ingredients in order to control the rate of burning. A graphite coat completes the series of steps in the operation.

A description of the acid and organic areas is now in order. Nitric acid is made in the acid area by the direct oxidation of ammonia. The ammonia is received in liquid form in tank cars and stored. It is first volatilized in a vaporizer equipped with steam coils and then mixed with hot air. This mixture is passed into a catalytic converter in which the fundamental chemical reaction occurs.

The resulting nitrogen oxide gases are cooled in a heat exchanger and partially condensed in a bank of condensers. The vapors are eventually put through an absorption tower and the condensate leaving the condenser as dilute nitric acid is also sent to the absorption tower. Counter-current scrubbing of the rising vapors results in 60 to 61 percent nitric acid.

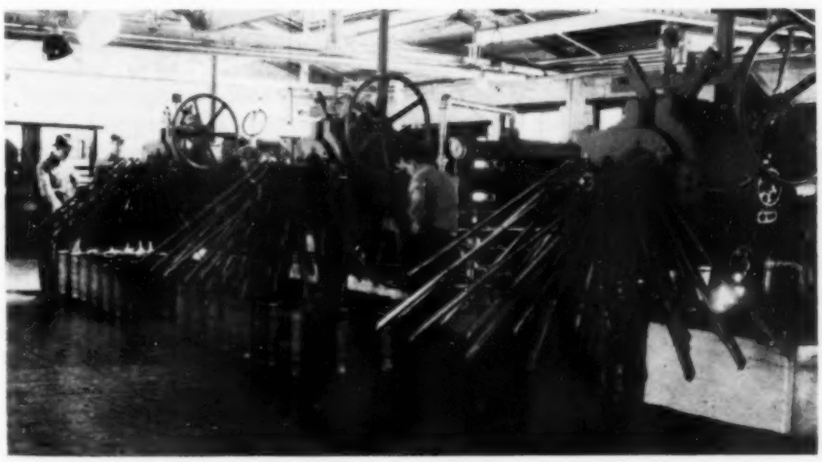
Gases from the top of the absorption tower are passed through a portion of the heat exchanger, through which the hot converted gases are sent, removing latent heat from the converted gas while being themselves heated. After accomplishing this cooling, the warmed gases are exhausted to the atmosphere through secondary compressors which pump 40-45 percent of the air needed for the oxidation process.

If it is to be used for nitrocellulose 60 percent acid must be concentrated to approximately 92 percent strength. Therefore, it is mixed with 92 to 96 percent sulphuric acid and concentrated. First, the mixture of nitric and sulphuric acids is preheated by steam coils and then sent into the top of a dehydrating column packed with chemical ware. From here it goes into a series of steam-heated boiler tubes and the heat drives the nitric acid gases back into the bottom of the dehydrating column. The nitric gases rise in the column and dilute nitric acid falls down, thus producing a stripping action. The sulphuric acid, since it is not volatile and is combined with water, is concentrated for reuse. The nitric acid vapors are then passed through a bleaching column, also packed with chemical ware, and thence to a condenser where the nitric acid is condensed out. It is now 92 to 95 percent nitric acid.

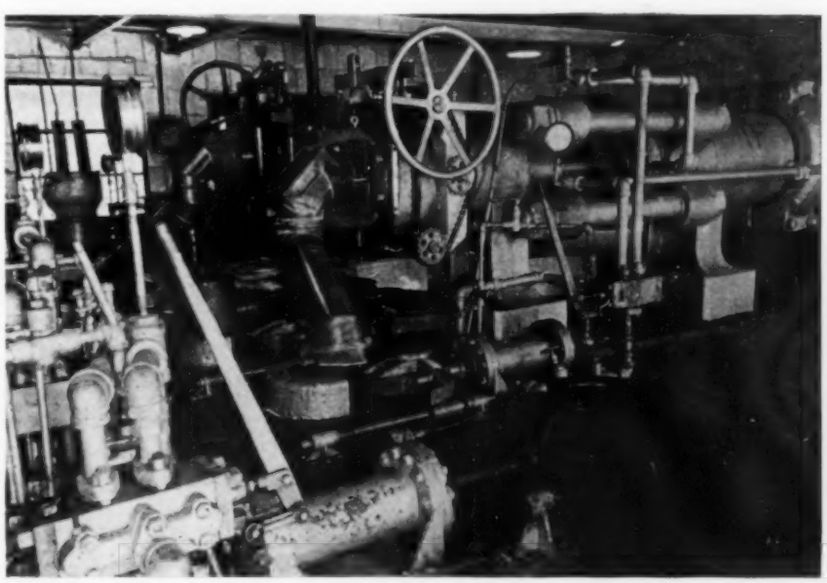
The organic area is divided into several sections. In the first, benzene is reacted with nitric and sulphuric acids to form nitro-benzene. The nitrobenzene is reduced to produce aniline, which is then either reacted catalytically under pressure with heat to form diphenylamine, or is allowed to react with methyl alcohol and sulphuric acid to obtain dimethylaniline.

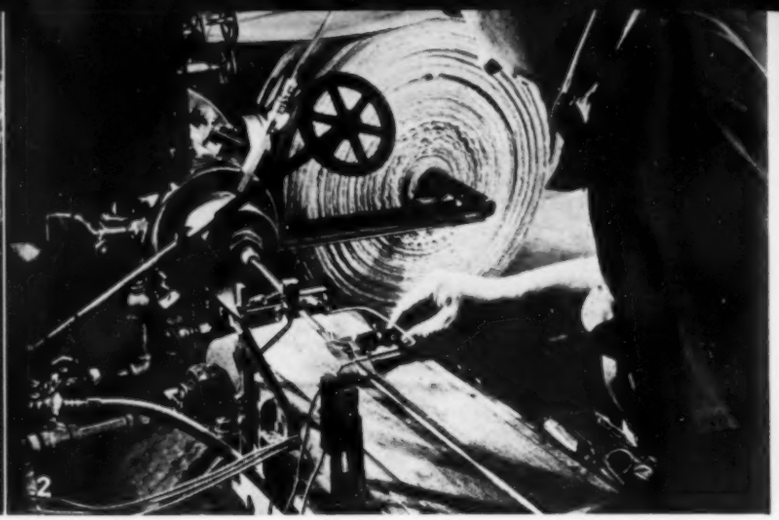
Smokeless powder is employed almost entirely as a propellant, and when finished is either stored or shipped out to nearby plants for bag or shell loading, as the case may be. If it is to be incorporated in the complete round, it is loaded into the cartridge shell cases. If, on the other hand, it is to be used in large guns as separate charges, it is loaded into cloth bags.

Graining presses extrude the powder through screens followed by a perforated die. Strings are then sent to the cutters



Powder is put through screens in a macaroni press in order to remove lumps and impurities. This powder is blocked once more





Producing a Rubber-Like Synthetic

EDITORIAL STAFF ARTICLE

RESISTANT to a high degree against refrigerant gases and organic solvent materials including petroleum products, chlorinated, aromatic and aliphatic hydrocarbons, and ketones, the rubber-like synthetic known as Resistoflex PVA is finding application in numerous types of use ranging from work gloves and aprons, to fuel, lubricant, hydraulic and vacuum hose for land and air transportation equipment. Versatility in methods of fabrication is one factor accounting for the diversity of applications. The material may be extruded as tubing, molded into sheets for gaskets, washers and diaphragms, cast, laminated and dipped. Molded sheets may, if desired, be re-molded for the production of various types of molded mechanical goods.

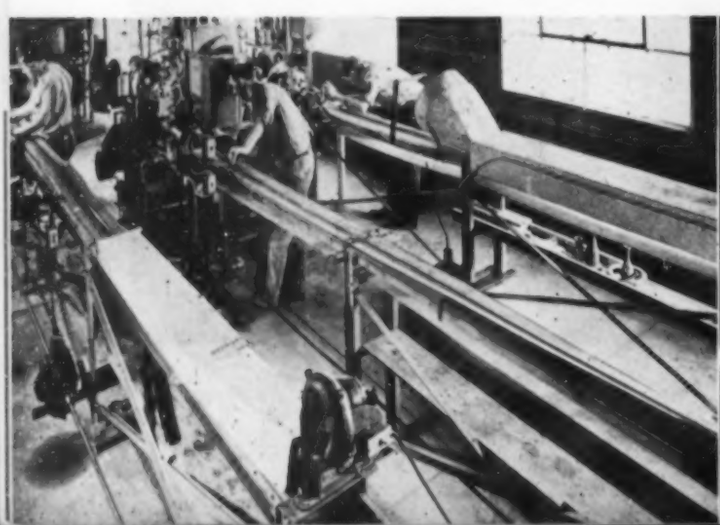
Another factor contributing to versatility is the fact that by varying the compounding, both physical and chemical properties can be altered considerably so as to adapt the product to widely varying requirements. For example, although Resistoflex PVA compounds generally tend to shrink slightly in the presence of most solvents, this characteristic can be modified so as to produce a slight swelling action under the same use conditions. The material has extremely high tensile strength, elongation, recovery and toughness, and these properties are only very slightly affected by exposure to most solvents.

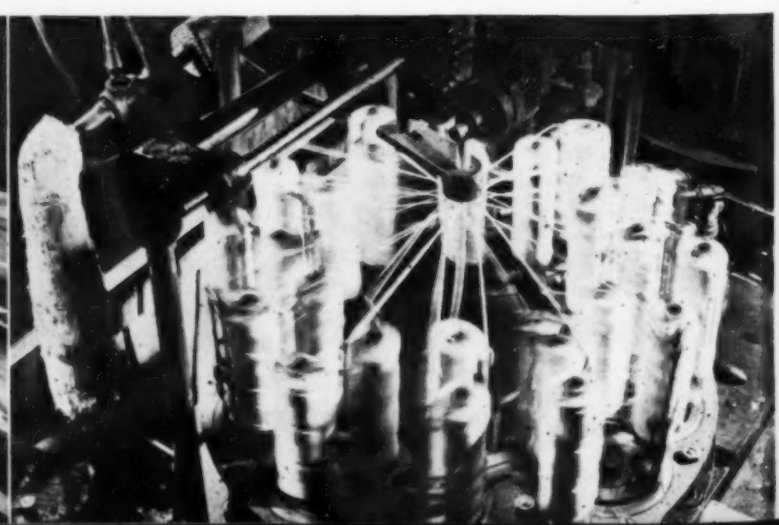
Polyvinyl alcohol is the base material which is modified in the compounding and processing so as to produce distinctive properties. The compounding is carried out by Resistoflex Corp. at the company's Belleville, N. J., plant. The preliminary mixture is produced in a simple ribbon type mixer and the batch, which at this stage is neither coherent nor plastic, is then put through a heated roller mill, emerging as a thin, coherent sheet somewhat resembling crepe rubber. This step, in which roll temperature and the thickness of the sheet produced are both carefully controlled, results in incipient fusion of the compounded particles, and a "sintering" together of adjacent particles.

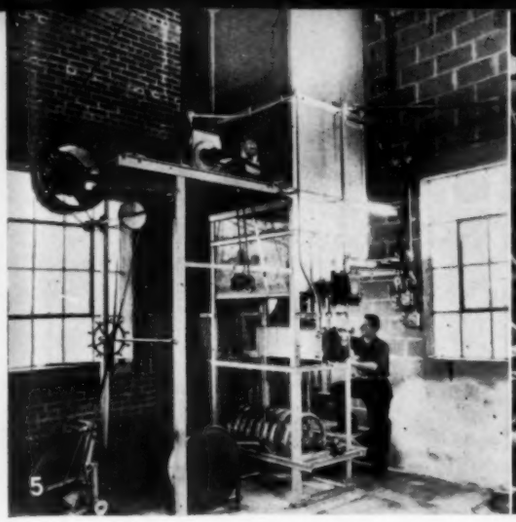
FORMING OPERATIONS

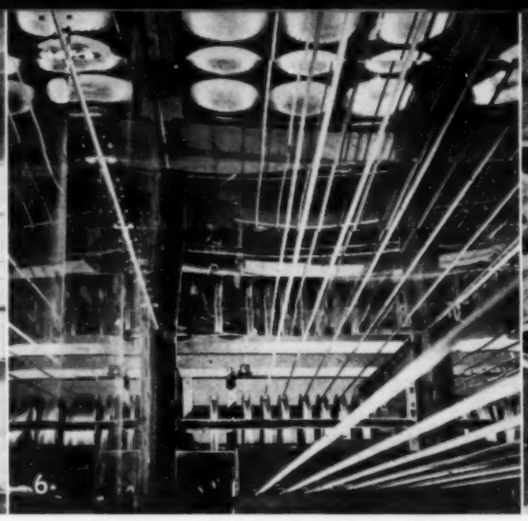
The compounded sheet is the starting point for the subsequent operations which may be either extrusion or molding. The first method is used for tubing and the second for sheet material which can be cut into gaskets or washers, or can be remolded for the production of mechanical goods. In either event, the pressure and heat to which the incompletely fused sheet is subjected results in completing the fusion of the particles and adjusting the final solvent content within accurately held limits. The material so produced is a tough, tear-

(1) After the compound is mixed, it is milled on heated rolls to produce a sheet of carefully controlled thickness and solvent content. (2) The milled sheet is fed in continuous lengths to an extruder from which it emerges as tubing. (3) Tubing leaves the extruder die and is carried to the wind-up by a canvas-belt conveyor for cooling. (4) Tubing is reinforced by one or more layers of fabric, using special high-speed braiders. Wire covers are applied on some constructions by similar equipment.









resistant plastic, having an amorphous structure which is best described as a solidified colloidal solution.

Although resins of this type have been known for nearly 20 years, they have been seriously considered only in the last ten. Some five years ago the American and Canadian patents on the processing of this class of materials were purchased by Resistoflex Corp. which then set about the development of methods for large-scale commercial production. Extrusion had already been practiced but one of the first problems of the company was perfection of this process. It was found to be particularly difficult to assure accurate dimensional control, but the problem was solved with a heated die and the adaptation of existing automatic control equipment which was modified on the basis of extensive experiment. Control of the tension in the extruded tube, produced by the belt which conveys the tube from the die, was also a difficult task which was finally solved by a sensitive electric control which senses the tube tension, maintaining it at the desired value by control of a variable speed transmission driving the belt.

Tubing can be extruded in a variety of diameters ranging from about ⅛ to 1 in. Leaving the die, it is carried by a canvas cooling belt some 40 or 50 ft. to the point where it is wound on a large metal reel, to await further processing. Depending on the requirements of each construction, the hose produced is reinforced by a number of layers of cotton or metal braid, applied by high-speed braiders of special design. An outer coating is provided of rubber, synthetic rubber, wire or lacquer, as required.

INFRA-RED DRYING

The hose lacquering operation is especially interesting. A drying tower has been developed, the inner surface of which is lined with brightly polished chrome-plated sheets. A battery of infra-red drying lamps is used, drying the lacquer at rates up to 4,000 ft. per hour. As many as 12 passes of hose can be threaded through the tower, to allow as many coats of lacquer to be applied. The coatings, incidently, are appled by Resistoflex PVA wipers which are said to give much longer life in this service than other materials that have been tried.

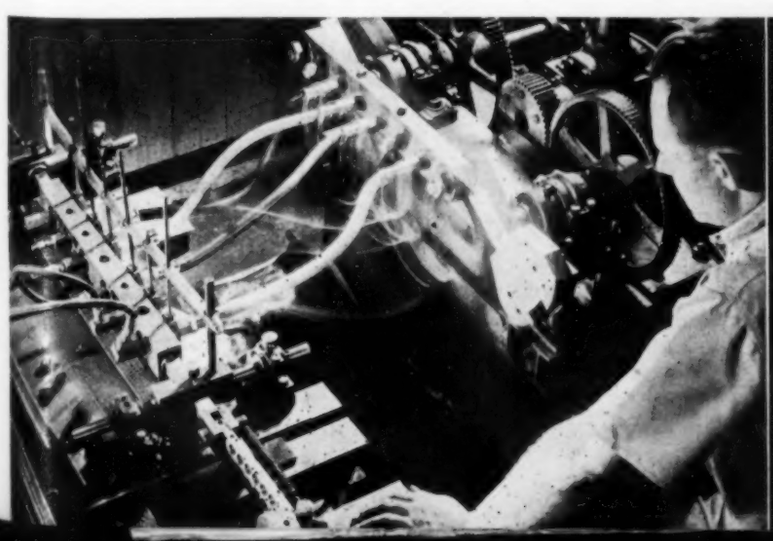
A considerable part of the company's output of hose and tubing is in the form of finished hose assemblies, cut to length and supplied with a variety of coupling designs spun or pressed on to the hose ends.

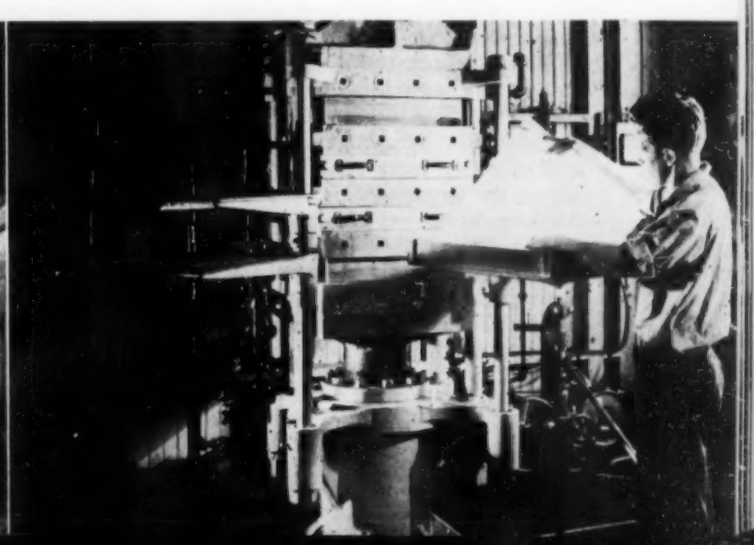
Resistoflex PVA sheets are produced by the simple process of molding the crude milled sheet between heated platens in a hydraulic press. If desired for added strength, fabric backing or inserts can be fused to the stock at this stage. The material can then either be delivered to the user in sheet form, or die-cut to desired final dimensions.

For dipping operations, as in the production of gloves, Resistoflex PVA is dissolved in a suitable mixture of solvents to form a viscous solution in which the porcelain forms are dipped, much as in the production of dipped rubber goods. Aprons and similar products are made by coating fabric with such a solution.

For permission to inspect the plant, and for assistance with the manuscript, *Chem. & Met.* is indebted to E. S. Peierls, president of Resistoflex Corp.

(5) This coating and drying tower can apply as many as 12 lacquer coats to braid-covered tubing at speeds up to 4,000 ft. per hour. (6) Looking downward inside the lacquer-drying tower; the infra-red drying lamps are clearly visible. (7) Here finished and semi-finished tubing is stored on metal reels. (8) One of the tests for finished hose is to subject it simultaneously, on this machine, to temperature, pressure, flexing, vibration and torsion. (9) Flat sheets are molded by pressing between heated platens.





Psychrometry of Cooling Towers

EDWARD SIMONS *Engineer, Redwood Manufacturers Co., San Francisco, Calif.*

Chem. & Met. INTERPRETATION

Three years ago Chem. & Met. published a group of articles on the fundamentals of water cooling tower design. Practical information was given to assist in actual design. Since their appearance, there have been a number of developments in both theory and practice. A new series, prepared by the same author, brings the subject up-to-date. The introductory article, presented here, is a quick review of fundamentals and a tie-in with the previous series.—*Editors.*

PSYCHROMETRY is the branch of physics that treats of the measurement of the degree of moisture, especially the moisture mixed with the air. The basic tools of this science are the gas laws, the principles of heat exchange, and the principles of molecular diffusion. It is often necessary for the engineer to use psychrometric formulas, even though he has lost the intimate impression of the fundamental actions. This article is a review of some of the basic principles and a projection of the principles into the field of cooling tower design and operation.

A water cooling tower may be defined as an apparatus in which the temperature of circulated water approaches the wet-bulb temperature of circulated air during the heat intersection that occurs between the air and the water.[1] During the evaporation which occurs with the heat exchange, the water which is evaporated changes from a liquid to a vapor. Therefore, the materials involved in the tower process are liquid water, water vapor, and gaseous air.

A closed container which is partially filled with water is illustrated in Fig. 1a; the container and its contents are maintained at a constant temperature. The portion of the container space which is above the surface of the water is originally evacuated. The molecules in the water are considered to be in a state of rapid motion with a mean velocity depending on the temperature of the water. Some molecules at the surface are able to escape from the liquid because their velocities are sufficiently high to project them into the vacuum. As this molecular escape continues, some of the vaporized molecules strike the surface of the liquid from which they emanate, and again become part of the liquid. When the number of molecules re-entering the surface is just equal to the number of molecules leaving it, a balance is established between the two phases, and the molecules which finally occupy the space of the original vacuum exert a pressure on the walls of the container. This pressure is called the pressure of the saturated vapor or saturation pressure. This pressure depends upon the nature of the liquid and upon the temperature.

A similar container in which the space above the water level is originally occupied by air is shown in Fig. 1b; the container and its contents are held at the same temperature as the container of Fig. 1a. If the pressure in the space above the water does not materially exceed one atmosphere, the tendency of the water molecules to escape is the same as in the case of the container of Fig. 1a, since the voids between the air particles are sufficiently large and numerous to enable the saturation process to proceed. However, the vaporized molecules do not distribute themselves so rapidly throughout the vessel, since collisions with the air molecules act to retard the vaporization. Consequently, the water evaporates more slowly into air than into a vacuum, but eventually the saturation pressure of the water vapor is built up to the same intensity that it would develop if the air were not present. The partial pressure of the water vapor is independent of the gas (air) which is also present in the container.

Dalton's Law states that in a mixture of gases the pressure of each constituent gas is independent of the presence of the others, and each gas exerts a partial pressure that is equal to the pressure which it would exert if it occupied the entire volume of the mixture at the temperature of the mixture. Furthermore, it states that the partial pressures of the constituents are additive. Therefore, the total pressure of a mixture is the sum of all of the partial pressures of the constituents. Dalton's Law may be applied to mixtures of dry air and water without the introduction of significant error. The total pressure of a mixture of air and water vapor is commonly the barometric pressure and is equal to the sum of the partial pressures of dry air and water vapor.

The perfect gas equation may be written

$$PV_g = 1{,}543 w T_R / M_g \qquad (1)$$

where

P is the total absolute pressure in lb. per sq. ft. V_g is the total volume in cu. ft., w is the weight of the gas in lb. in volume V_g, T_R is absolute temperature in deg. R. (T_R = deg. F. + 460) and M_g is the molecular weight of the gas.[2a]

Moisture-free air has the following average analysis:[2b]

Component	Percent by Volume	Molecular Weight	Lb. in 1 molal volume of air
Oxygen (O_2)	20.95	32.00	6.70
Nitrogen (N_2)	78.08	28.02	21.88
Carbon dioxide (CO_2)	0.03	44.00	0.01
Argon, etc	0.94	40.	0.38
Total weight of 1 mol of air is			28.97 lb

Similarly, for water vapor:

Component	Atomic Weight	Lb. in 1 molal volume of vapor
Hydrogen (H_2)	1.008	2.016
Oxygen (O)	16.00	16.00
Total weight of one mol of water vapor		18.02 lb.

The weight of a column of mercury one sq. ft. in area and one in. deep is 70.73 lb. Therefore, where a column of mercury is used as a pressure indicator, a variation of one in. in the indicating column represents a variation in the intensity of pressure of 70.73 lb. per sq. ft. (0.4912 lb. per sq. in.) If P_G is equal to the pressure of a gas in in. Hg,

$$P = 70.73 P_G \qquad (2)$$

The volume occupied by one lb. of dry, moisture-free air is selected for use in Eq. (1); accordingly, w is

equal to one lb. The weight of water vapor associated with one lb. of dry air has been variously called: mixing ratio, proportionate humidity, mass or density ratio, absolute humidity and specific humidity. In this article, this quantity is given the symbol H; and, since the lb. of dry air is used as a basic unit, H is defined as the humidity of the air for the purposes of this article. Eq. (1) is used as follows:

$$\text{For air, } 70.73\,(B - p_s)\,V_H = 1{,}543 \times 1 \times T_R/28.97 \quad (3)$$

$$\text{For water, } 70.73 p_s V_H = 1{,}543 H T_R/18.02 \quad (4)$$

Eq. (4) divided by Eq, (3) yields

$$p_s/(B - p_s) = 28.97H/18.02 \quad (5)$$

or

$$H = 0.6220 p_s/(B - p_s) \quad (6)$$

In the preceding equations, P_s is equal to the partial pressure of water vapor in the air, and B is equal to the barometric pressure, both are expressed in inches of mercury.

The value of P_s must be known in order that Eq. (6) may be solved. If the water in the container of Fig. 1b were maintained at a constant temperature during the saturation process, the air in the upper portion of the container would become saturated at the temperature of the water, and the temperature of the air would be the temperature of adiabatic saturation. On the other hand, if it were possible to expose the portion of the container above the water to a moving stream of air of infinite quantity, the water in the lower part of the container would ultimately assume the temperature of adiabatic saturation of the air supply. The wet-bulb temperature of the air determined by a proper psychrometric technique may be used as the temperature of adiabatic saturation. Carrier's equation [3a] may then be used in the following form:

$$p_s = [p_w - (B - p_w)\,(t - t_w)]/(2{,}800 - 1.3t_w) \quad (7)$$

Fig. 1a

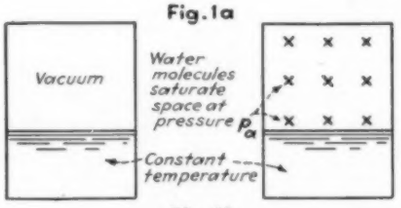
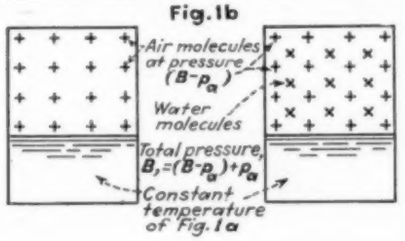


Fig. 1b



NOMENCLATURE

B = Barometric pressure, in. Hg.
C$_v$ = Volume of air per minute passing through a given tower cross section, cu. ft. per min.
G = Rate of air flow through tower, lb. bone dry air per min.
H = Air humidity, lb. of water vapor per lb. bone dry air.
H$_s$ = Saturated humidity at T$_R$, lb. water vapor per lb. dry air.
L = Water rate through cooling tower, lb. per min.
M$_w$ = Molecular weight of a gas, general case.
p$_s$ = Partial pressure of water vapor in the main air stream, in. Hg.
p$_w$ = Saturated pressure of water vapor at the wet bulb temperature, in. Hg.
P = Absolute pressure, lb. per sq. ft.
P$_a$ = Total absolute pressure, atm.
P$_G$ = Pressure of a gas, in. Hg.
r$_w$ = Latent heat of vaporization of water vapor at t$_w$, B.t.u. per lb.
t = Temperature of the air-water mixture, or dry-bulb temperature, deg. F.
t$_w$ = Wet-bulb temperature.
T = Bulk temperature of the water, deg. F.
T$_R$ = Absolute temperature of a gas, deg. Rankine.
V$_G$ = Total volume of a gas, cu. ft.
V$_H$ = Humid volume of air, cu. ft. moist air containing 1 lb. dry air.
w = Weight of a gas, lb.
Σ = The Sigma Function, in main air stream, B.t.u. per lb. dry air.
$\cong$ = Denotes sensible equivalence.

SUBSCRIPTS

T = Refers to conditions at water temperature, T.
w = Refers to the wet-bulb condition.
1 = Refers to the conditions at the air entrance and water exit of a counter-flow tower.
2 = Refers to the conditions at the water entrance and air exit of a counter-flow tower.

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where

p_s = actual partial pressure of water vapor in the air, in. Hg.; p_w = saturation pressure at wet-bulb temperature, in. Hg. (Table I gives values of the saturation pressures at intervals of 0.1 deg. F.); B = barometric pressure, in. Hg.; t = dry-bulb (air) temperature, deg. F.; t_w = wet-bulb temperature, deg. F.

The volume which is occupied by one lb. of dry air and its associated water vapor is known as the humid volume of the air-water mixture. If V_H is used to designate the humid volume, Eq. (3) may be rewritten as follows:

$$70.73\,(B - p_s)\,V_H = 1543\,T_R/28.97 \quad (8a)$$

or

$$V_H = 0.7531\,T_R/(B - p_s) \quad (8b)$$

Thus, if the cubic feet per minute of air-water mixture passing through a given cross section of an apparatus are designated by C_v, and if pounds per minute of dry air passing through this apparatus are designated by G,

$$C_v = GV_H \quad (9a)$$

or

$$G = C_v/V_H \quad (9b)$$

The weight of moisture per lb. of dry air in a mixture of air and water vapor depends on the dew point temperature alone. As long as there is no condensation of moisture, the dew point temperature remains constant. Let P_s equal the saturated vapor pressure at T_R, and let H_s equal the corresponding saturated humidity at T_R. Then, for a given unchanged space (as one cu. ft.), and with constant temperature,

$$p_s/p_s = \text{Relative humidity} \quad (10)$$

For saturation conditions, Eq. (6) becomes

$$H_s = 0.6220 p_s/(B - p_s) \quad (11)$$

Eq. (6) divided by Eq. (11) gives

$$H/H_s = p_s\,(B - p_s)/\,p_s\,(B - p_s) \quad (12)$$

The percent humidity is $100H/H_s$; it is the humidity of air at a given temperature expressed as a percentage of the humidity of saturated air at the same temperature. Relative humidity is based upon fixed volume; percent humidity is based upon fixed weight of bone dry air. Eq. (12) indicates that percent relative humidity equals percent humidity only at saturation.

If an air-water mixture is cooled without change of barometric pressure, the partial pressure of the water vapor will not change during the cooling, since the ratio $p_s/(B-p_s)$ of Eq. (6) remains constant with constant humidity. Under these conditions the partial pressures of air and water vapor will remain constant. When, therefore, the temperature is decreased until the air becomes saturated, the partial pressure of the water vapor becomes a saturated pressure, the temperature is the dew-point temperature, and the percent humidity equals the percent relative humidity. Consequently, the humidity at any temperature is equal to the humidity at the dew-point temperature, and the partial pressure of water vapor is equal to the saturated pressure at the dew-point.

The Sigma Function of W. H. Car-

rier for an air-water mixture[3b] may be written:

$$\Sigma = 0.24\,(t - 0) + Hr_w + 0.45H\,(t - t_w) \qquad (13)$$

The coefficient of 0.24 is the mean specific heat at constant pressure for dry air, and the coefficient 0.45 is the mean specific heat at constant pressure for water vapor; r_w is the latent heat of vaporization at T_w, and is expressed to B.t.u. per lb. The Sigma Function is a constant for any two states of the air-water mixture at the same temperature of adiabatic saturation (wet-bulb temperature). It should be noted that the temperature of make-up water for evaporation should be at a temperature equal to the wet-bulb temperature of the air. In a cooling tower, both the temperature of the make-up water and the wet-bulb temperature of the air vary throughout the apparatus. Therefore, it is necessary to apply a slight correction to the direct use of the sum of the Sigma Function of air entering the apparatus plus the heat to be rejected into the air.

It may be noted that the heat quantity defined by the Sigma Function excludes the enthalpy of the liquid water at the temperature of the wet-bulb, t_w. If the specific heat of liquid water is taken as one B.t.u. per lb. per deg. F., the enthalpy of the liquid at t_w above a temperature base of 32 deg. F. is equal to $H(t_w - 32)$.

At low partial pressures the enthalpy of steam, whether superheated or saturated, may be expressed by a straight-line empirical formula.[3c] William Goodman[4] has stated that for pressures below 5 lb. abs. and temperatures below 500 deg. F., a value of the enthalpy per lb. of water vapor equal to 1,061 + 0.45t will introduce deviations that will be less than 0.25 percent of the values given by the Keenan and Keyes[5] steam tables. Furthermore, he states that for saturated steam at 200 deg. F., and a pressure of 11.53 lb. abs., the deviation is slightly less than 0.50 percent. With Goodman's enthalpy as a basis,

$$r_w = 1{,}061 + 0.45t_w - (t_w - 32)$$

or

$$r_w = 1{,}093 - 0.55t_w \qquad (14)$$

The rectangle of Fig. 2 represents a typical counter-flow cooling tower apparatus. In such a gas-liquid phase exchange system, operating with continuous flow, it is justifiable to neglect the generally small mechanical and potential energy changes in considering the energy transfer between the phases. The water inlet is at 2 and the air inlet is at 1; the water outlet is at 1 and the air outlet is at 2.

Table I—Pressure of saturated water vapor in inches of mercury for temperatures in degrees Fahrenheit

Temp.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	Temp.
30	0.1664	0.1671	0.1678	0.1685	0.1692	0.1699	0.1706	0.1713	0.1720	0.1727	30
31	.1734	.1741	.1748	.1755	.1762	.1769	.1775	.1782	.1789	.1796	31
32	.1803	.1811	.1818	.1826	.1833	.1841	.1848	.1856	.1863	.1871	32
33	.1878	.1886	.1893	.1901	.1909	.1917	.1924	.1932	.1940	.1947	33
34	.1955	.1963	.1971	.1979	.1987	.1995	.2003	.2011	.2019	.2027	34
35	0.2035	0.2043	0.2052	0.2060	0.2068	0.2077	0.2085	0.2093	0.2101	0.2110	35
36	.2118	.2127	.2135	.2144	.2152	.2161	.2169	.2178	.2186	.2195	36
37	.2203	.2212	.2221	.2230	.2239	.2248	.2256	.2265	.2274	.2283	37
38	.2292	.2301	.2310	.2319	.2328	.2338	.2347	.2356	.2365	.2374	38
39	.2383	.2393	.2402	.2412	.2421	.2431	.2440	.2450	.2459	.2469	39
40	0.2478	0.2488	0.2498	0.2507	0.2517	0.2527	0.2537	0.2547	0.2556	0.2566	40
41	.2576	.2586	.2596	.2606	.2616	.2627	.2637	.2647	.2657	.2667	41
42	.2677	.2688	.2698	.2709	.2719	.2730	.2740	.2751	.2761	.2772	42
43	.2782	.2793	.2804	.2815	.2826	.2837	.2847	.2858	.2869	.2880	43
44	.2891	.2902	.2914	.2925	.2936	.2948	.2959	.2970	.2981	.2993	44
45	0.3004	0.3016	0.3027	0.3039	0.3050	0.3062	0.3074	0.3085	0.3097	0.3108	45
46	.3120	.3132	.3144	.3156	.3168	.3180	.3192	.3204	.3216	.3228	46
47	.3240	.3252	.3265	.3277	.3290	.3302	.3314	.3327	.3339	.3352	47
48	.3364	.3377	.3390	.3403	.3416	.3429	.3441	.3454	.3467	.3480	48
49	.3493	.3506	.3520	.3533	.3546	.3560	.3573	.3586	.3599	.3613	49
50	0.3626	0.3640	0.3654	0.3667	0.3681	0.3695	0.3709	0.3723	0.3736	0.3750	50
51	.3764	.3778	.3792	.3807	.3821	.3835	.3849	.3863	.3878	.3892	51
52	.3906	.3921	.3935	.3950	.3964	.3979	.3994	.4008	.4023	.4037	52
53	.4052	.4067	.4082	.4097	.4112	.4128	.4143	.4158	.4173	.4188	53
54	.4203	.4219	.4234	.4250	.4265	.4281	.4297	.4312	.4328	.4343	54
55	0.4359	0.4375	0.4391	0.4407	0.4423	0.4440	0.4456	0.4472	0.4488	0.4504	55
56	.4520	.4537	.4553	.4570	.4586	.4603	.4620	.4636	.4653	.4669	56
57	.4686	.4703	.4720	.4738	.4755	.4772	.4789	.4806	.4824	.4841	57
58	.4858	.4876	.4893	.4911	.4929	.4947	.4964	.4982	.5000	.5017	58
59	.5035	.5053	.5072	.5090	.5108	.5127	.5145	.5163	.5181	.5200	59
60	0.5218	0.5237	0.5256	0.5275	0.5294	0.5313	0.5331	0.5350	0.5369	0.5388	60
61	.5407	.5426	.5446	.5465	.5485	.5504	.5523	.5543	.5562	.5582	61
62	.5601	.5621	.5641	.5661	.5681	.5702	.5722	.5742	.5762	.5782	62
63	.5802	.5823	.5843	.5864	.5885	.5906	.5926	.5947	.5968	.5988	63
64	.6009	.6030	.6052	.6073	.6094	.6116	.6137	.6158	.6179	.6201	64
65	0.6222	0.6244	0.6266	0.6288	0.6310	0.6332	0.6354	0.6376	0.6398	0.6420	65
66	.6442	.6465	.6487	.6510	.6533	.6556	.6578	.6601	.6624	.6646	66
67	.6669	.6692	.6716	.6739	.6763	.6786	.6809	.6833	.6856	.6880	67
68	.6903	.6927	.6951	.6975	.6999	.7024	.7048	.7072	.7096	.7120	68
69	.7144	.7169	.7194	.7218	.7243	.7268	.7293	.7318	.7342	.7367	69
70	0.7392	0.7418	0.7443	0.7469	0.7494	0.7520	0.7546	0.7571	0.7597	0.7622	70
71	.7648	.7674	.7701	.7727	.7754	.7780	.7806	.7833	.7859	.7886	71
72	.7912	.7939	.7966	.7993	.8020	.8048	.8075	.8102	.8129	.8156	72
73	.8183	.8211	.8239	.8267	.8295	.8323	.8350	.8378	.8406	.8434	73
74	.8462	.8491	.8520	.8548	.8577	.8606	.8635	.8664	.8692	.8721	74
75	0.8750	0.8780	0.8809	0.8839	0.8868	0.8898	0.8928	0.8957	0.8987	0.9016	75
76	.9046	.9077	.9107	.9138	.9168	.9199	.9230	.9260	.9291	.9321	76
77	.9352	.9383	.9415	.9446	.9478	.9509	.9540	.9572	.9603	.9635	77
78	.9666	.9698	.9731	.9763	.9795	.9828	.9860	.9892	.9924	.9957	78
79	.9989	1.002	1.006	1.009	1.012	1.016	1.019	1.022	1.025	1.029	79
80	1.032	1.036	1.039	1.042	1.046	1.049	1.053	1.056	1.060	1.063	80
81	1.066	1.070	1.073	1.077	1.080	1.084	1.088	1.091	1.095	1.098	81
82	1.102	1.105	1.109	1.112	1.116	1.120	1.123	1.127	1.131	1.134	82
83	1.138	1.142	1.145	1.149	1.153	1.156	1.160	1.164	1.168	1.171	83
84	1.175	1.179	1.183	1.186	1.190	1.194	1.198	1.202	1.206	1.209	84
85	1.213	1.217	1.221	1.225	1.229	1.233	1.237	1.241	1.245	1.249	85
86	1.253	1.257	1.261	1.265	1.269	1.273	1.277	1.281	1.285	1.289	86
87	1.293	1.297	1.301	1.306	1.310	1.314	1.318	1.322	1.326	1.331	87
88	1.335	1.339	1.343	1.348	1.352	1.356	1.360	1.365	1.369	1.373	88
89	1.378	1.382	1.386	1.391	1.395	1.400	1.404	1.408	1.413	1.417	89
90	1.422	1.426	1.431	1.435	1.440	1.444	1.449	1.453	1.458	1.462	90
91	1.467	1.471	1.476	1.481	1.485	1.490	1.495	1.499	1.504	1.508	91
92	1.513	1.518	1.523	1.527	1.532	1.537	1.542	1.546	1.551	1.556	92
93	1.561	1.566	1.571	1.575	1.580	1.585	1.590	1.595	1.600	1.605	93
94	1.610	1.615	1.620	1.625	1.630	1.635	1.640	1.645	1.650	1.655	94
95	1.660	1.665	1.670	1.676	1.681	1.686	1.691	1.696	1.701	1.707	95
96	1.712	1.717	1.722	1.728	1.733	1.738	1.744	1.749	1.754	1.759	96
97	1.765	1.770	1.776	1.781	1.787	1.792	1.797	1.803	1.808	1.814	97
98	1.819	1.825	1.830	1.836	1.842	1.847	1.853	1.858	1.864	1.870	98
99	1.875	1.881	1.887	1.892	1.898	1.904	1.910	1.915	1.921	1.927	99
100	1.933	1.938	1.944	1.950	1.956	1.962	1.968	1.974	1.980	1.986	100
101	1.992	1.998	2.004	2.010	2.016	2.022	2.028	2.034	2.040	2.046	101
102	2.052	2.058	2.064	2.070	2.077	2.083	2.089	2.095	2.101	2.108	102
103	2.114	2.120	2.127	2.133	2.139	2.146	2.152	2.158	2.165	2.171	103
104	2.178	2.184	2.191	2.197	2.204	2.210	2.217	2.223	2.230	2.236	104
105	2.243	2.250	2.256	2.263	2.270	2.276	2.283	2.290	2.297	2.303	105
106	2.310	2.317	2.324	3.331	2.337	2.344	2.351	2.358	2.365	2.372	106
107	2.379	2.386	2.393	2.400	2.407	2.414	2.421	2.428	2.435	2.442	107
108	2.449	2.456	2.464	2.471	2.478	2.485	2.492	2.500	2.507	2.514	108
109	2.521	2.529	2.536	2.544	2.551	2.558	2.566	2.573	2.581	2.588	109
110	2.596	2.603	2.611	2.618	2.626	2.634	2.641	2.649	2.656	2.664	110
111	2.672	2.679	2.687	2.695	2.703	2.710	2.718	2.726	2.734	2.742	111
112	2.749	2.757	2.765	2.773	2.781	2.789	2.797	2.805	2.813	2.821	112
113	2.829	2.837	2.846	2.854	2.862	2.870	2.878	2.887	2.895	2.903	113
114	2.911	2.919	2.928	2.936	2.945	2.953	2.961	2.970	2.978	2.986	114
115	2.995	3.003	3.012	3.021	3.029	3.038	3.046	3.055	3.063	3.072	115
116	3.081	3.089	3.098	3.107	3.116	3.125	3.133	3.142	3.151	3.160	116
117	3.169	3.178	3.187	3.196	3.205	3.214	3.223	3.232	3.241	3.250	117
118	3.259	3.268	3.277	3.287	3.296	3.305	3.314	3.324	3.333	3.342	118
119	3.351	3.361	3.370	3.380	3.389	3.399	3.408	3.417	3.427	3.436	119

Table I—Pressure of saturated water vapor (Cont.)

Temp.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	Temp.
120	3.446	3.455	3.465	3.475	3.485	3.494	3.504	3.514	3.523	3.533	120
121	3.543	3.553	3.563	3.572	3.582	3.592	3.602	3.612	3.622	3.632	121
122	3.642	3.652	3.662	3.672	3.683	3.693	3.703	3.713	3.723	3.733	122
123	3.744	3.754	3.764	3.775	3.785	3.796	3.806	3.816	3.827	3.837	123
124	3.848	3.858	3.869	3.879	3.890	3.901	3.911	3.922	3.933	3.943	124
125	3.954	3.965	3.976	3.987	3.998	4.008	4.019	4.030	4.041	4.052	125
126	4.063	4.074	4.085	4.096	4.108	4.119	4.130	4.141	4.152	4.163	126
127	4.175	4.186	4.197	4.209	4.220	4.232	4.243	4.254	4.266	4.277	127
128	4.289	4.300	4.312	4.324	4.335	4.347	4.359	4.370	4.382	4.394	128
129	4.406	4.417	4.429	4.441	4.453	4.465	4.477	4.489	4.501	4.513	129
130	4.525	4.537	4.550	4.562	4.574	4.586	4.598	4.611	4.623	4.635	130
131	4.647	4.660	4.672	4.685	4.697	4.710	4.722	4.735	4.747	4.760	131
132	4.773	4.785	4.798	4.811	4.824	4.837	4.849	4.862	4.875	4.888	132
133	4.901	4.914	4.927	4.940	4.953	4.966	4.979	4.992	5.005	5.018	133
134	5.031	5.045	5.058	5.072	5.085	5.098	5.112	5.125	5.139	5.152	134
135	5.165	5.179	5.193	5.206	5.220	5.234	5.247	5.261	5.275	5.289	135
136	5.302	5.316	5.330	5.344	5.358	5.372	5.386	5.400	5.414	5.428	136
137	5.442	5.456	5.471	5.485	5.499	5.514	5.528	5.542	5.557	5.571	137
138	5.585	5.600	5.614	5.629	5.644	5.658	5.673	5.688	5.702	5.717	138
139	5.732	5.747	5.762	5.776	5.791	5.806	5.821	5.836	5.851	5.866	139
140	5.881	5.896	5.912	5.927	5.942	5.958	5.973	5.988	6.004	6.019	140
141	6.034	6.050	6.065	6.081	6.097	6.112	6.128	6.143	6.159	6.175	141
142	6.190	6.206	6.222	6.238	6.254	6.270	6.286	6.302	6.318	6.334	142
143	6.350	6.366	6.383	6.399	6.415	6.432	6.448	6.464	6.481	6.497	143
144	6.513	6.530	6.546	6.563	6.580	6.597	6.613	6.630	6.647	6.663	144
145	6.680	6.697	6.714	6.731	6.748	6.765	6.782	6.799	6.816	6.833	145
146	6.850	6.867	6.885	6.902	6.920	6.937	6.954	6.972	6.989	7.007	146
147	7.024	7.042	7.060	7.077	7.095	7.113	7.131	7.149	7.166	7.184	147
148	7.202	7.220	7.238	7.257	7.275	7.293	7.311	7.329	7.348	7.366	148
149	7.384	7.403	7.421	7.440	7.458	7.477	7.495	7.514	7.532	7.551	149
150	7.569	7.588	7.607	7.626	7.645	7.664	7.683	7.702	7.721	7.740	150
151	7.759	7.778	7.798	7.817	7.836	7.856	7.875	7.894	7.913	7.933	151
152	7.952	7.972	7.992	8.011	8.031	8.051	8.071	8.091	8.110	8.130	152
153	8.150	8.170	8.190	8.210	8.230	8.251	8.271	8.291	8.311	8.331	153
154	8.351	8.372	8.392	8.413	8.433	8.454	8.475	8.495	8.516	8.536	154
155	8.557	8.578	8.599	8.620	8.641	8.662	8.683	8.704	8.725	8.746	155
156	8.767	8.788	8.810	8.831	8.853	8.874	8.895	8.917	8.938	8.960	156
157	8.981	9.003	9.025	9.047	9.069	9.091	9.112	9.134	9.156	9.178	157
158	9.200	9.222	9.245	9.267	9.290	9.312	9.334	9.357	9.379	9.402	158
159	9.424	9.447	9.470	9.492	9.515	9.538	9.561	9.584	9.606	9.629	159
160	9.652	9.675	9.699	9.722	9.745	9.769	9.792	9.815	9.838	9.862	160
161	9.885	9.909	9.932	9.956	9.980	10.00	10.03	10.05	10.07	10.10	161
162	10.12	10.15	10.17	10.19	10.22	10.24	10.27	10.29	10.32	10.34	162
163	10.36	10.39	10.41	10.44	10.46	10.49	10.51	10.54	10.56	10.59	163
164	10.61	10.64	10.66	10.69	10.71	10.74	10.76	10.79	10.81	10.84	164
165	10.86	10.89	10.91	10.94	10.97	10.99	11.02	11.04	11.07	11.09	165
166	11.12	11.15	11.17	11.20	11.22	11.25	11.28	11.30	11.33	11.36	166
167	11.38	11.41	11.44	11.46	11.49	11.52	11.54	11.57	11.60	11.62	167
168	11.65	11.68	11.70	11.73	11.76	11.79	11.81	11.84	11.87	11.89	168
169	11.92	11.95	11.98	12.00	12.03	12.06	12.09	12.12	12.14	12.17	169
170	12.20	12.23	12.26	12.28	12.31	12.34	12.37	12.40	12.43	12.45	170
171	12.48	12.51	12.54	12.57	12.60	12.63	12.66	12.69	12.71	12.74	171
172	12.77	12.80	12.83	12.86	12.89	12.92	12.95	12.98	13.01	13.04	172
173	13.07	13.10	13.13	13.16	13.19	13.22	13.25	13.28	13.31	13.34	173
174	13.37	13.40	13.43	13.46	13.49	13.52	13.55	13.58	13.61	13.64	174
175	13.67	13.70	13.73	13.76	13.80	13.83	13.86	13.89	13.92	13.95	175
176	13.98	14.01	14.05	14.08	14.11	14.14	14.17	14.21	14.24	14.27	176
177	14.30	14.33	14.37	14.40	14.43	14.46	14.50	14.53	14.56	14.59	177
178	14.63	14.66	14.69	14.72	14.76	14.79	14.82	14.86	14.89	14.92	178
179	14.96	14.99	15.02	15.06	15.09	15.12	15.16	15.19	15.22	15.26	179
180	15.29	15.33	15.36	15.39	15.43	15.46	15.50	15.53	15.56	15.60	180
181	15.63	15.67	15.70	15.74	15.77	15.81	15.84	15.88	15.91	15.95	181
182	15.98	16.02	16.05	16.09	16.12	16.16	16.20	16.23	16.27	16.30	182
183	16.34	16.37	16.41	16.45	16.48	16.52	16.55	16.59	16.63	16.66	183
184	16.70	16.74	16.77	16.81	16.85	16.88	16.92	16.96	16.99	17.03	184
185	17.07	17.11	17.14	17.18	17.22	17.26	17.29	17.33	17.37	17.41	185
186	17.44	17.48	17.52	17.56	17.60	17.63	17.67	17.71	17.75	17.79	186
187	17.83	17.86	17.90	17.94	17.98	18.02	18.06	18.10	18.14	18.18	187
188	18.21	18.25	18.29	18.33	18.37	18.41	18.45	18.49	18.53	18.57	188
189	18.61	18.65	18.69	18.73	18.77	18.81	18.85	18.89	18.93	18.97	189
190	19.01	19.06	19.10	19.14	19.18	19.22	19.26	19.30	19.34	19.38	190
191	19.43	19.47	19.51	19.55	19.59	19.63	19.68	19.72	19.76	19.80	191
192	19.84	19.89	19.93	19.97	20.01	20.06	20.10	20.14	20.18	20.23	192
193	20.27	20.31	20.36	20.40	20.44	20.49	20.53	20.57	20.62	20.66	193
194	20.70	20.75	20.79	20.84	20.88	20.92	20.97	21.01	21.06	21.10	194
195	21.14	21.19	21.23	21.28	21.32	21.37	21.41	21.46	21.50	21.55	195
196	21.59	21.64	21.68	21.73	21.78	21.82	21.87	21.91	21.96	22.00	196
197	22.05	22.10	22.14	22.19	22.24	22.28	22.33	22.38	22.42	22.47	197
198	22.52	22.56	22.61	22.66	22.70	22.75	22.80	22.85	22.89	22.94	198
199	22.99	23.04	23.08	23.13	23.18	23.23	23.28	23.32	23.37	23.42	199
200	23.47	23.52	23.57	23.62	23.66	23.71	23.76	23.81	23.86	23.91	200
201	23.96	24.01	24.06	24.11	24.16	24.21	24.26	24.31	24.36	24.41	201
202	24.46	24.51	24.56	24.61	24.66	24.71	24.76	24.81	24.86	24.91	202
203	24.97	25.02	25.07	25.12	25.17	25.22	25.27	25.32	25.37	25.42	203
204	25.47	25.53	25.58	25.63	25.69	25.74	25.79	25.84	25.90	25.95	204
205	26.00	26.06	26.11	26.16	26.21	26.27	26.32	26.37	26.43	26.48	205
206	26.53	26.59	26.64	26.70	26.75	26.80	26.86	26.91	26.97	27.02	206
207	27.08	27.13	27.19	27.24	27.30	27.35	27.41	27.46	27.52	27.57	207
208	27.63	27.68	27.74	27.79	27.85	27.91	27.96	28.02	28.08	28.13	208
209	28.19	28.25	28.30	28.36	28.42	28.47	28.53	28.59	28.64	28.70	209
210	28.76	28.81	28.87	28.93	28.99	29.05	29.11	29.16	29.22	29.28	210
211	29.34	29.40	29.46	29.51	29.57	29.63	29.69	29.75	29.81	29.86	211
212	29.92										

The mean specific heat at constant pressure for the dry air is taken as 0.25 B.t.u. per lb. per deg. F.; the mean specific heat at constant pressure for water vapor is taken as 0.45 B.t.u. per lb. per deg. F.

Let L = the water flow, lb. per min.; G = the air flow, lb. per min, bone-dry air; T = water temperature, deg. F. (not deg. R.); t = dry-bulb temperature of the air, deg. F.; t_w = wet-bulb temperature of the air, deg. F.; H = humidity, lb. of water vapor per lb. of bone-dry air.

The subscript 1 refers to conditions of both water and air at the air inlet; the subscript 2 refers to conditions at the air outlet.

A heat balance is written using T_1 as the datum temperature:

$$\text{Input} = \text{Output} \quad (15)$$

$$\text{Input} = L_2 (T_2 - T_1)/G + 0.24 (t_1 - T_1) + 0.45H_1 (t_1 - T_1) + H_1 r_{T1} \quad (16)$$

$$\text{Output} = L_1 (T_1 - T_1)/G + 0.24 (t_2 - T_1) + 0.45H_2 (t_2 - T_1) + H_2 r_{T1} \quad (17)$$

The respective values of input and output of Eq. (16) and (17) are substituted in Eq. (15) as follows:

The input is equal to the output; Eq. (16) equals Eq. (17). The algebraic equalities clear to

$$L_2 (T_2 - T_1)/G = 0.24 (t_2 - t_1) + 0.45 (H_2 t_2 - H_2 T_1 - H_1 t_1 + H_1 T_1) + r_{T1} (H_2 - H_1) \quad (18)$$

From Eq. (14)

$$r_{T1} = 1{,}093 - 0.55 T_1 \quad (19)$$

Therefore,

$$r_{T1} (H_2 - H_1) = 1{,}093H_2 - 0.55H_2 T_1 - 1{,}093H_1 + 0.55H_1 T_1 \quad (20)$$

Eq. (20) is substituted in Eq. (18), and the clearing yields

$$L_2 (T_2 - T_1)/G = (0.24t_2 + 0.45H_2 t_2 + 1{,}093H_2) - (0.24t_1 + 0.45H_1 t_1 + 1{,}093H_1) - T_1 (H_2 - H_1) \quad (21)$$

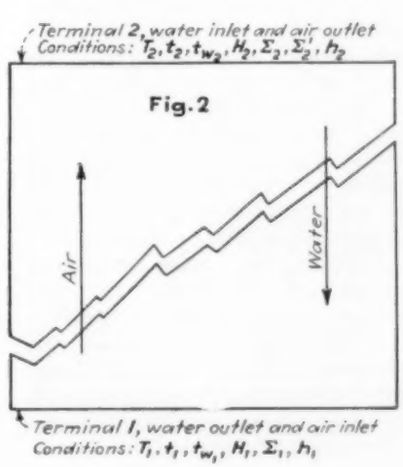
From Eq. (13) and Eq. (14)

$$\Sigma_2 = 0.24t_2 + 1{,}093H_2 - 0.55H_2 t_{w2} + 0.45H_2 t_2 - 0.45H_2 t_{w2} \quad (22)$$

or

$$\Sigma_2 + H_2 t_{w2} = 0.24t_2 + 0.45H_2 t_2 + 1{,}093H_2 \quad (23)$$

Likewise,


Terminal 2, water inlet and air outlet
Conditions: $T_2, t_2, t_{w_2}, H_2, \Sigma_2, \Sigma_2', h_2$
Fig. 2
Air
Water
Terminal 1, water outlet and air inlet
Conditions: $T_1, t_1, t_{w_1}, H_1, \Sigma_1, h_1$

$$\Sigma_1 + H_1 t_{w1} = 0.24 t_1 + 0.45 H_1 t_1 + 1{,}093 H_1 \quad (24)$$

Expressions in Eq. (21) which are identical with those in (23) and (24) are replaced by their equalities as given in Eq. (23) and (24) respectively. Thus,

$$I_2 (T_2 - T_1)/G = \Sigma_2 + H_2 t_{w2} - \Sigma_1 - H_1 t_{w1} - H_2 T_1 + H_1 T_1 \quad (25)$$

Finally,

$$\Sigma_2 = L_2 (T_2 - T_1)/G + \Sigma_1 - H_2 (t_{w2} - T_1) - H_1 (T_1 - t_{w1}) \quad (26)$$

In Eq. (26), the expression

$$-H_2(t_{w2} - T_1) - H_1(T_1 - t_{w1})$$

is small numerically compared to the rest of the equation to the right of the sign of equality. Therefore, for purposes of practical cooling tower design,

$$\Sigma_2 \cong (L_2/G)(T_2 - T_1) + \Sigma_1 \quad (27)$$

The approximate outgoing wet-bulb may be determined by the use of Eq. (27).

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Wartime Problems to be Solved

Some of the problems of chemical warfare that must be solved by this country were outlined by Col. M. E. Barker speaking before the student body of the College of William and Mary in February. This article is a brief abstract of a portion of the talk.

THERE are numerous problems of a chemical or engineering nature the solution of which will be desperately needed within the next year to aid the nation's war efforts. Some of these problems are being investigated by the National Defense Research Committee, the Chemical Warfare Service and other organizations. Never before in the nation's history has such a vast coordinated research and development program been undertaken.

Progress in chemistry, in physics, in industry, in methods and weapons of warfare, come from those who dare to dream logical dreams as well as by the unremitting toil of the technicians who gather the facts which the engineer can use in reducing the invention to practical utility.

Let us consider a few examples of specific jobs ahead of us and point out some of the tasks confronting the chemist today, keeping in mind all the time that the chemist is just one player on our ball team.

In normal years the United States uses about one-half million tons of new rubber. Last year an even larger amount was consumed. Most of the supply of raw rubber is cut-off now. It is essentially the chemists' job to make greater use of reclaimed rubber by "unvulcanizing" it, and by restoring the molecules of the used rubber to their original state.

Americans have taken the tin can for granted. There must be fewer tin cans now in order to save the steel sheet and the tin coat. An immediate, intense and continual search for packaging materials must be made from plentiful domestic materials. Why not make such containers from cotton and corn cobs? It can be done. The cotton could be formed into sheets and these bonded with plastics from the corn cob, or from the protein residue left from the corn during its processing into sirup.

Quinine. What a challenge to the organic chemists! Are they going to sit placidly by and watch our own malaria-bearing mosquitoes wage a terrible bacteriological warfare for the Japs? We need several million ounces yearly. Most of this comes from the plantations of the East Indies.

Who knows what may be accomplished by the proper heat, sound, X-ray, or physical treatment of iron alloyed with such cheap and plentiful domestic raw materials as silicon, carbon and titanium. We must have huge quantities of corrosion-resistant metals for chemical plant equipment. Perhaps the gold and silver in our vaults might well be put to work as the linings of reaction kettles and stills. What a joy a gold-lined reactor would be to the man who prays each day that his thousand-gallon precious glass-lined reactor will not crack that day. And why not? The gold would not be used up. It would be doing its bit for National Defense. Therefore, let's take out a few tons of gold and a few hundred tons of silver from the vaults and use them to overcome some of our serious corrosion problems which are bound to get worse due to the growing scarcity of Monel and stainless steel. Then, too, other solutions to the corrosion problem might be found.

There are not enough sheep to furnish all the wool needed. If cotton could be converted into a fiber having the desirable effects of wool, what a boon it would be to the cotton farmer, the cotton mill owner, and the worker. Here is a problem that every Southern chemist should take to heart. Who knowns that a process cannot be worked out that will make cotton the King of all fibers? We know now that it can be made water resistant and almost fireproof.

A good start has been made in solving the problem of vitamins. At least it is known that vitamins are useful and can be produced. A plentiful supply is essential for the national health and well-being. Improvements are in order.

A few years ago synthetic toluol was a dream. Now, thousands of gallons are made every day. The job has just started, for without toluol there will be no TNT. There is plenty of room for progress.

Five years ago butadiene was a rare chemical. Next year thousands of tons will be made. That will be a fair beginning, but a beginning only. Here is a great field for the organic chemist and the chemical engineer. Synthetic rubber is here to stay. For this we must have butadiene in great quantity and low price. The same applies to styrene and to acrylo nitrile.

There is comparatively little bauxite in the United States. Other supplies available here are not inexhaustible, but there is plenty of aluminum in clay which is scattered over this entire country. The aluminum is there. We need it. It can be extracted and a commercial process will be a real contribution to National Defense and to America. We need aluminum for airplanes, for making thermit fillings for incendiary bombs, and for many other uses, both military and civil.

A lot of better things are required such as a good ten-cent dust mask; waterproof, air permeable unwettable fabrics of many kinds for tents, gloves, clothes; fire-resistant cloth for use of guards in munition works, workmen in powder and incendiary plants, and soldiers in tanks and airplanes; better smoke filters for air purifying devices; new synthetic fibers having a diameter of a micron or less; and others.

Pidgeon Ferro-Silicon Process For Magnesium

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Chem. & Met. INTERPRETATION

The process for the production of magnesium developed by L. M. Pidgeon of the Canadian National Research Laboratories is of current interest in view of the fact that several plants in which this process will be used are now under construction in the United States. They will, however, use natural gas instead of electricity for fuel.—*Editors.*

THE PIDGEON PROCESS for the production of metallic magnesium consists essentially in reacting burnt dolomite lime with crushed ferro-silicon in an externally heated, sealed, metallic retort, which is kept under vacuum by means of vacuum pumps. The metal, 99.98 per cent pure, is recovered in a solid, dense crystalline mass, which is subsequently melted down under flux and poured into ingots. The crystalline masses may also be added direct to molten aluminum for the production of aluminum-magnesium alloys.

The process is similar to ordinary commercial zinc practice. It differs only in the fact that the retorts for distilling magnesium are of metal instead of fire clay, and the distillation takes place under vacuum in the case of magnesium, whereas zinc is distilled at atmospheric pressure.

The retorts are approximately the same size as used for zinc, the operating temperatures are the same, and the quantity of magnesium recovered per retort per day (40-60 lb.) is the same as recovered from a zinc retort. When the recoverable zinc in zinc ore costs the zinc distiller 2.5c. per lb., metal can be produced by the retort process and sold at a profit of 6c. per lb.

The fact that the retorts are small and the amount of magnesium collected and removed at one time is limited to 15-20 lb., and the fact that the charging and discharging of the retorts is carried out after the breaking of the vacuum and the admission of air to the retort establishing ordinary pressures means that the fire and explosion hazard is reduced to a minimum.

The size of a plant is dependent upon the number of retorts operated. A bank of retorts is set in a heating chamber and constitutes a furnace. The larger the furnaces and the more of them, the easier it is to establish the maneuvers necessary to hand charge and hand discharge the retorts and remove the residues economically. Handling facilities for placing and replacing the retorts are also simplified and cheaper with the large scale operations.

The principal items of operating cost are:

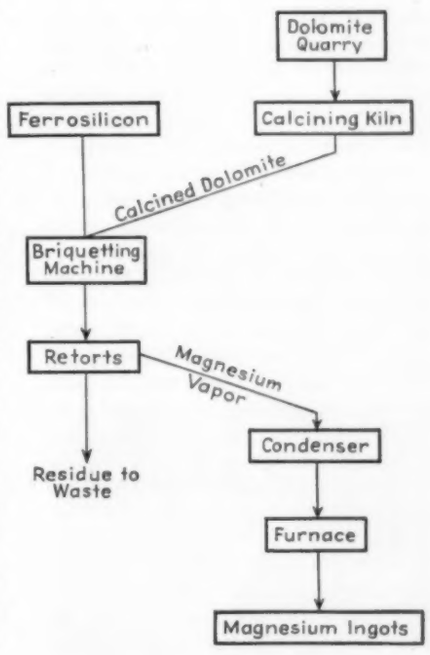
1—Ferro-silicon
2—Metallic retort maintenance
3—Heat
4—Maintenance of vacuum equipment
5—Labor
6—Burnt dolomite
7—Maintenance of electric heaters
8—Power for crushing, grinding, briquetting

Due to the ease of control and uniformity with which electric power can be converted into heat, electricity is the ideal method of heating the metallic retorts of the Pidgeon process. Canada has as cheap or cheaper electric power than any other place in the world, hence it should have the most favorable costs in these two items. Similarly, the alloy metal retorts, which are high in nickel (35 percent) and have electric power as a considerable item in their cost of production, can be produced as cheaply in Canada as anywhere else. Dolomite limestone is abundant and can be quarried cheaply in the vicinity of low cost electric power. Technically trained engineers for the supervision of the vacuum aspects of the operation are available in Canada and any ordinary furnace labor can within a reasonable time be developed into skilled operatives for the charging and discharging operations.

First estimates of capital cost for a 10 ton per day plant indicate $1.25 to $1.50 capital outlay for each dollar's worth of sales per year. This is figuring the magnesium as selling at 25c. per lb. under present conditions. This is only slightly above the capital costs per annual sales dollar of product of most chemical and metallurgical operations and is very much below the figures that may be calculated from the published data for any other magnesium process.

The indicated low capital and operating costs are due primarily to the fact that the flowsheet for the Pidgeon process is extremely simple. The quarrying of limestone and the burning of lime is an old art and very cheap. There is no elaborate purification of the raw materials. Ferro-silicon is bought on the open market and crushed fine in standard crushing equipment. Solid metal is made direct from the briquetted burnt dolomite and ferro-silicon mixture without any intermediate stages. Finally, there are no elaborate services to be maintained for the operation. Power for crushing, grinding, briquetting, heat, vacuum, and cooling water are all that is necessary, so that auxiliary expenses are minimized.

A Pidgeon process plant could be built and put into operation in a much shorter time than any other magnesium process.



Stainless Steel Developments in Process Industries

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Chem. & Met. INTERPRETATION

Chemical engineers who are interested in materials of construction will find much valuable information in this article on chromium steels, including a description of the standard nitric acid test which is widely used throughout the United States as a means of measuring quality of stainless steel. A later article will discuss the chromium-nickel steels.—*Editors.*

THIS DISCUSSION considers the subject of stainless steel from the viewpoint of a large consumer, the process industries. It is well known that the advent of stainless steel encouraged the chemist and chemical engineer to greater endeavor which has resulted in many new developments in the process industries. On the other hand, we know that continuous demands made by the chemical engineer for better materials for the construction of equipment to resist corrosion, erosion and oxidation over a wide range of temperatures and pressures are in a large measure responsible for the progress made in metallurgy. It is obvious that the steel industry cannot justify research covering all the problems of the chemical industry, and yet, the development of new alloys must be conditioned by the development of new products in the chemical industry. This mutual interest in the progress of metallurgy led to the establishment of metallurgical research departments in the various units of the process industries. A few of the larger units in the chemical industry pioneered this movement, which today has been adopted by a large cross-section of the process industries. The function of these metallurgical groups, aside from evaluation of commercial alloys, improvement and development of alloys to meet the demands of highly specialized processes, an investigation of fabrication processes, is to collect and correlate metallurgical data with the chemical, engineering, design and fabrication factors for the purpose of aiding in the selection of the most suitable materials for process equipment. In the selection of material for a specific process, the following factors must be considered:

1. Time element
2. First cost vs. equipment obsolescence
3. Service life
4. Effect of material on product (contamination and catalytic effects)
5. Design and fabrication limits

These factors are well known to the chemical engineer. However, the metallurgist rarely appreciates that in the development of a new product the time element is probably the most important factor in its financial success. Competing companies conducting research in the same field may develop essentially the same product by somewhat different processes at approximately the same time. Speed in getting the plant into production will establish a market precedence for the new product or the value of the increased production often will offset the initial cost of the equipment. Then again, the pace of research development is so rapid that within a relatively short period, a new and better method for manufacturing the same product may be discovered, making all or most of the original process equipment obsolete. Therefore, first cost must be weighed against equipment obsolescence. It would be foolish to select a high cost material which tests indicate would last 100 years when a lower cost material is suitable for the life of the process.

During the experimental stage of a new development, the research chemist should cooperate with the metallurgist concerning materials for the future plant. This enables the metallurgist to make corrosion tests on the most promising alloys in the process reactions while they are still being conducted in glass apparatus. These or similar tests duplicating process conditions determine the relative corrosion resistance and the catalytic effect of the metal on the product. It is sometimes necessary to reject an alloy because some alloying element has an adverse effect on the yield of the product. Based on results of these preliminary tests, the pilot plant is constructed and during the same period in which the engineer is stepping up the process from the laboratory to the semi-plant operations, the metallurgist and the design engineer are testing the alloys as fabricated equipment or as additional test samples under actual service conditions. Because of the many variables encountered in process reactions, the only safe method for selecting an alloy is to test the material under exact process conditions.

Fabrication and design limitations must be kept constantly in mind in considering test materials. An alloy steel may have all the necessary qualifications for a specific application, and yet these qualifications may be destroyed by improper fabrication and design of equipment. It is also useless to make a long series of tests and find that the favorite alloy cannot be produced or fabricated in the form necessary for the application.

With this in view, it is planned to cite some of the problems in the process industries and trace developments in the field of metallurgy which have contributed in overcoming the difficulties that have arisen in the use of stainless steel for process equipment.

Stainless steel covers over 50 compositions that may be classified in accordance with their structural characteristics into three broad groups as martensitic, ferritic and austenitic steels. With the exception of a brief description of the martensitic steels, this article will be confined to the

group known as ferritic steels, which are used very extensively in the fabrication of process equipment. Let us first review the basic alloys in these three groups, noting their outstanding structural, chemical and physical characteristics, which are briefly designated in the accompanying table.

Martensitic Steels

Martensitic steels can be hardened by heat treatment to give a wide variety of physical properties. The stainless steels covered in this group are those containing from 12 to 14 percent chromium, 0.15 percent max. carbon, and the 12 to 18 percent chromium grade containing 0.20 to 1.00 percent carbon. The low-carbon grade, commonly called turbine steel, is generally used for engineering purposes where its superior physical properties may be used to advantage. This grade is also used extensively as a clad veneer or lining for large vessels and columns in the oil industry to resist moderate corrosion conditions. The high-carbon grades are the well-known cutlery steels, which were discovered by Harry Brearley in England, in 1912. It has been said that approximately 50 tons of this material was produced in England in 1914, and the first commercial heat was made in the United States the next year.

Ferritic or Straight Chromium Steels

The ferritic chromium steels are those containing chromium from 15 to 30 percent with low carbon content, maximum 0.15 percent. These steels show no significant transformation on quenching from a high temperature, and hence remain essentially ferritic at all temperatures. Actually, the steels of this group with less than 20 percent chromium contain a slight amount of high-temperature austenite and therefore harden slightly on cooling rapidly from a high temperature.

Although the use of martensitic steels developed rapidly after their introduction in the United States, it was not until the development of a new process for the manufacture of nitric acid that the straight chromium steels became commercial. During the first World War, nitric acid was made by reacting sodium nitrate with sulphuric acid. Steel, lead, cast iron, Duriron, brick and glass were the commercial materials available for handling this process. These materials permitted the chemical industry to meet the production demands of the time, but they were unsatisfactory from the standpoint of maintenance due to either lack of corrosion resistance or poor mechanical properties. For a number of years prior to this period, chemists were investigating a process for making nitric acid synthetically by the direct oxidation of ammonia with the oxygen in the air. This process involved the handling of corrosive liquids and gases at high temperatures and pressures. Therefore, the major problem was one of construction materials and one which remained unsolved until the advent of stainless steel. The 15 to 18 percent chromium steels were found suitable, and hence, the first synthetic nitric acid plant was built by the duPont company at Gibbstown, N. J., in 1926. In a relatively short period of time, the old method for manufacturing nitric acid became obsolete, and as a result, ammonia oxidation plants similar to the duPont plant, requiring huge tonnages of 15 to 18 percent chromium iron, were built all over the world.

Equipment in this plant was of riveted construction. The size of the structures compare favorably with the largest tanks and columns manufactured today. The assembled absorption column, which contained a series of trays, bubble caps, down pipes, etc., was approximately 60 ft. high, about 5 ft. in diameter, with a wall thickness of approximately ½ in.

In order to produce this steel and assemble equipment in these quantities and in such large pieces at this stage in their development required the utmost cooperation between steel producers, fabricators and consumer. Although this period precedes the establishment of metallurgical research in the chemical industry, the idea was probably born in this initial installation.

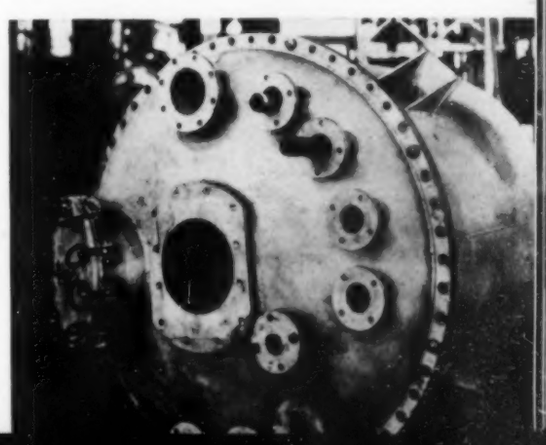
The next most important step in the fabrication of equipment made from these steels was the lowering of the chromium content slightly in order to improve shock resistance.

Classification and Properties—Stainless Steels

Martensitic		Ferritic		Austenitic		
% Cr	% C	% Cr	% C	% Cr	% Ni	% C
(4– 6	.15 max.)	15–16	.10 max.	18	8	.20 max.
(8–10	.15 max.)	16–18	.12 max.	25	12	.20 max.
12–14	.15	20–28	.25 max.	25	20	.20 max.
12–18	.20–1.00					
Hardenable		Yes	No	No		
Magnetic		Yes	Yes	No		
Toughness		High	Low	Very High		
Oxidation		1,200–1,400 deg.F.	1,400–2,000 deg.F.	1,400–2,100 deg.F.		
Abrasion		Very good	Good	Good		
Corrosion						
Intergranular		No	No	Yes		
Effective additions		Cb-Ti-Mo-Ni-Se-Al	Cb-Ti-Mo-N-Ni-Mn-Se	Cb-Ti-Mo-Mn-Cu-Si-N-S-Se		

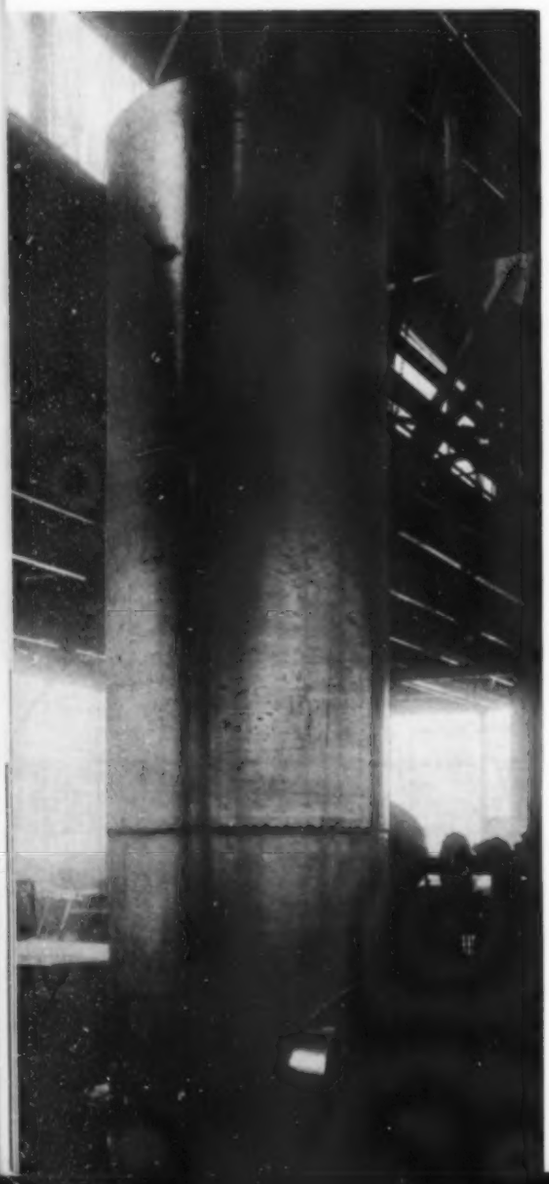
An all-welded tank car used for transporting strong nitric acid. The car is made of 15-16 percent chromium steel, which is considered best for handling nitric

This steam jacketed still has been constructed from 15-16 percent chromium steel. It will be used for reclaiming nitrocellulose for lacquer



This resulted in the development of the 15-16 percent chromium grade containing 0.10 percent maximum carbon, which is in use today. It was found after a series of corrosion and physical tests that this was the range of chromium content which would give the optimum combination of chemical and physical characteristics. All other elements being equal, the corrosion resistance of the straight chromium steels to boiling nitric acid or other strong oxidizing media is increased as the chromium is increased. Therefore, the adoption of a lower chromium content for the manufacture of nitric acid equipment meant sacrificing some corrosion resistance to obtain better shock resistance. Holding the chromium within this narrow range also contributed to the early development of welding and fabrication of pressure vessels of the straight chromium steels.

Absorption tower fabricated from 28 percent chromium steel. This tower will be used for reclaiming dilute nitric acid from waste NO_2 gases



Welding

The commercial welding of the straight high chromium steels began in 1928 but little progress was made until about 1931 because of the inability of the fabricator to produce corrosion-resistant welds. However, during this three-year period, or shortly afterward, this problem was solved by the application of special fabrication precautions and improved welding technique. Successful welding was accomplished by the electric arc process using a rod of such a composition that the deposited metal was essentially the same as the base metal. The chromium and carbon were adjusted in the weld rod to compensate for chromium lost by oxidation and the carbon picked up during welding. The rod required a special carbon-free coating which blanketed the molten metal with a slag containing deoxidizing and fluxing agents. A factor of prime importance was the adoption of small diameter rods which resulted in less heat input and increased the number of weld layer beads necessary to fill a given welding groove. The lower heat input inhibited grain growth and the multi-layer construction afforded some grain refinement of the underlying beads.

During fabrication, the work was preheated to a temperature of approximately 300 deg. F. to increase its ductility. In some cases, the welds were peened immediately following welding while the weld was still hot to refine the grain structure. When necessary, the equipment was given intermediate anneals during welding or forming operations, but in all cases it had to be followed by a final heat-treatment. The final heat-treatment consisted of holding equipment for a period of four hours per inch of thickness at a temperature between 1,400 and 1,450 deg. F. and cooling slowly (100 deg. per hr.) in the furnace to a temperature of 1,100 deg. F. before removal. This heat-treatment, which relieved stresses, eliminated the detrimental effects of cold working, and restored the maximum corrosion resistance of the plate, weld, and area adjacent to the weld, was found to be mandatory for fabricated straight chromium iron equipment to be used for corrosive service. Welded specimens, cut from 15-16 percent chromium-iron equipment welded in this manner, were bent flat through 180 deg. without cracking and the weld metal had a Charpy impact value between 10 and 25 ft. lb.

Gradually, welded construction began to displace riveted construction so that by 1936 nearly all straight chromium steel equipment was fabricated by welding. Several nitric acid plants of all-welded construction are being fabricated today of 15 to 16 percent chromium iron as a part of the war program to expand the production of ammunition. Also, all-welded tank cars are being constructed of this material to transport nitric acid for our munition plants manufacturing TNT and smokeless powder.

The fabrication of the higher chromium steels (20-30 percent chromium) closely parallels that of the 15-18 percent chromium steels in all fields except welding of pressure vessels or equipment requiring high resistance to shock at relatively low temperatures. The shock resistance of welds made in vessels containing over 18 percent chromium is very low as measured by standard impact methods. However, in spite of this deficiency, considerable process equipment welded with 25 percent chromium rods, or 25 percent chromium, 12 percent nickel rods are in use today. The austenitic 25-12 chromium-nickel rods are often used in welding 20-30 percent chromium steel for the purpose of maintaining tough weld deposits where corrosion due to electrolysis of the metal is not a factor. However, this does not prevent grain

Typical 65 Per Cent Boiling Nitric Acid Tests on Martensitic, Ferritic and Austenitic Steels—A.S.T.M.

Laboratory	Corrosion Rate* In. Penetration Per Mo. 18% Cr. 8% Ni	17% Cr	13% Cr
1	.00096	.00225	.00917
2	.00089	.00342	.00839
3	.00102	.00245	.00884
4	.00095	.00232	.00915
5	.00101	.00250	.00989
Total average	.00096	.00258	.00908

Cr	Ni	C	Heat Treatment
17.5	9.24	.09	Water quenched from 2,000 deg. F.
17.3	.00	.09	Annealed 1,600 deg. F. Furnace cooled.
13.1	....	.12	Annealed 1,300 deg. F. Furnace cooled.

* Each Rate = Average 8 specimens.

growth in the area adjacent to the weld, which area has slightly inferior physical properties and, because of stresses set up in welding, will have lower corrosion resistance. It is preferred to use filler rod of the same composition as the deposit metal and to heat treat the equipment in order to relieve stresses and retain maximum corrosion resistance, by holding for several hours at a temperature of 1,600 deg. F. followed by rapid cooling in air.

It should be made clear that the lack of toughness ascribed to welds of 20-30 percent chromium steels is a condition that exists only at temperatures below 500 deg. F. These materials are highly ductile at higher temperatures, which makes welded construction ideal for high-temperature applications.

Research is being conducted to improve further the ductility of the weld deposits of these steels at atmospheric temperatures. The low-ductility values obtained in weld deposits of 28 percent chromium steel is due to a large columnar grain structure which cannot be refined by heat-treatment. These steels are subject to rapid grain growth when exposed to processing or welding temperatures. The only method for reducing grain size of these steels is cold or hot working which is illustrated by the greatly increased toughness of rolled sheets or drawn tubes. Grain growth can be inhibited by the presence of nitrogen in the ratio of 130 to 180 parts chromium to 1 part of nitrogen. This practice has been used by the steel industry for some time to increase the yield from high-chromium ingots as well as increase the toughness of the wrought steels.

Nitrogen in Weld Rod

Several experiments have shown that the addition of nitrogen to weld rod greatly improves the toughness of weld deposits. Investigations are now in progress to increase the utility of the 18-20 percent chromium steels by the introduction of nitrogen into the weld metal. Improved toughness in weld deposits of the steels in the higher chromium range will permit the process industry to take advantage of the increased corrosion resistance, particularly in those processes involving high pressure. Preliminary data from at least three of the concerns cooperating in this study lead to the prediction that the use of nitrogen and a special heat-treatment will become commercial practice in future welding of these steels. Results show that nitrogen reduces the grain size of weld deposit metal similarly to the reduction in grain size illustrated for high-chromium ingots, and that the toughness is increased to give Charpy impact values between 20-25 ft.-lb.

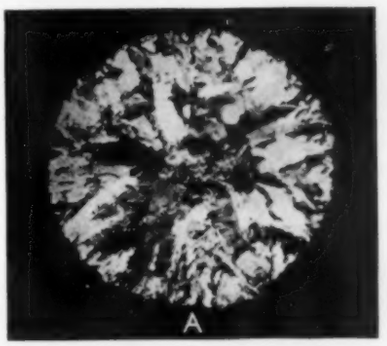
Development of the Nitric Acid Test For Stainless Steels

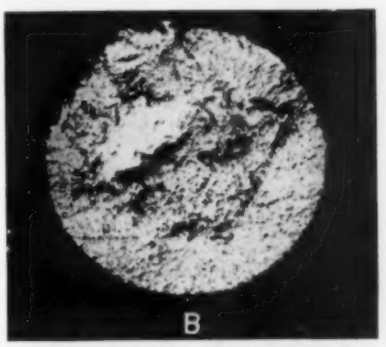
Before leaving the straight chromium steels, it is advisable to discuss briefly the standard 65 percent boiling nitric acid test which is widely used throughout the United States as a means of measuring the quality of stainless steels. This test is an outgrowth of the early laboratory investigation for a suitable material for equipment handling nitric acid. The investigators were amazed at the accurate results obtained and the ease of reproducing corrosion data when testing stainless steels in strong nitric acid. As a result of further research evaluating all factors involved, such as concentration and volume of acid, size of specimen, surface condition, time exposure, etc., the standard nitric acid test that is known today was developed. The test consists of determining the loss in weight on a prepared specimen of stainless steel for each of five successive 48-hr. periods in boiling 65 percent nitric acid. The loss in weight is converted by a factor to corrosion rate in inches penetration per month. A collaborative testing program sponsored by Sub-Committee A-10 of the A.S.T.M. and the laboratories of 16 companies investigated this test in 1932 and found it to be satisfactory.

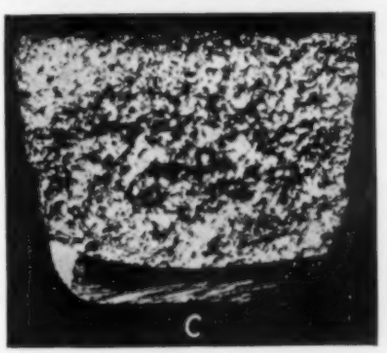
The use of this test as a tool for determining the quality of stainless steel has been adopted by most of the research laboratories in the steel industry as well as the process industries. This test is only a measure of quality of stainless steels, and nitric acid results obtained have no bearing upon the resistance of a given stainless steel to various corrosive media. It was stated earlier that this can only be determined by testing the stainless steel under actual operating conditions. However, if the nitric acid test indicates that the quality of stainless steel is inferior to that of the sample tested under exact process conditions, there is no assurance that this inferior steel will be suitable for the process. This test has been of value in investigating plant equipment failures. Many fabricators have testified that the test has contributed more than any other factor to the development of a good quality stainless steel weld metal.

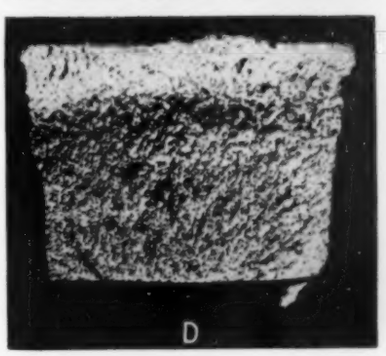
All-welded 18 percent chromium steel pressure vessel for benzoate of soda

Nitrogen in straight chromium steels reduces grain size and increases toughness. A and C contain low nitrogen while B and D contain high nitrogen









Arc Welding

CARL A. CRANE

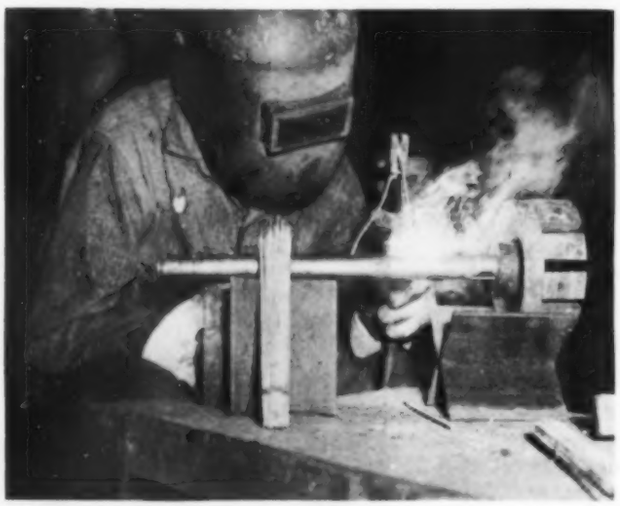
Using a corrosion-resistant electrode in welding a flange to a stainless steel evaporator vent pipe. Such electrodes give welds with corrosion-resistance equal to or greater than the parent metal

LIKE MANY OTHER plants throughout the country, the Amino Products Co., has been faced with the necessity of keeping maintenance costs down to a minimum. This is a feat which, without arc welding, would have become increasingly difficult with the rise in cost of materials due to the defense program and the severe priorities on metals such as stainless steel, bronze, Monel metal and nickel.

Arc welding is used almost continuously by our plant for general maintenance work. It has been our

Arc welding fixed the pin holes in the fitting for this stainless steel feed line for a centrifugal in ten minutes at a cost of about $1. Replacement would have cost $18

Pitted portions of this propeller were built up by use of electrodes for arc welding bronze, brass and copper. Welding costs were $7 as compared to a replacement cost of $27



This stainless steel shaft, worn down about ¼-in. from contact with the packing, was built up by welding and then machined to proper dimensions. Welding took 30 minutes and cost about $3 as against $40 for replacement

Cuts Maintenance Costs

Superintendent, Amino Products Co., Rossford, Ohio

experience that large savings in both time and money can be made by this all-purpose repair process. Arc welding can be used for any type of metal, whether it be ordinary rolled steel, sheet metal, stainless steel or many others. On these pages are illustrated a few typical examples of how this welding procedure has been applied in the plant of the Amino Products Co. Experienced maintenance men can easily get ideas for applying arc welding to their own particular maintenance problems and thus conserve both materials and man-power.

Monel metal responds readily to arc welding. The Monel cutter bar for a centrifugal unloader shown here was built up by welding at a saving of about $146 over replacement

This 5-minute arc welding job saved $42.50. The pitted pump housing would have cost $44 for replacement. "Aerisweld" electrodes were used

This rotor agitator was fabricated from 2½-in. steel pipe and ⅜-in. plate for the paddle. It was built in the shop of the Amino Products Co., which is equipped with a 150-amp. arc welder

This steam manifold was arc welded from extra heavy 4-in. pipe and a 3-in. outlet. This and all other photographs on these pages were taken and supplied through the courtesy of the Lincoln Electric Co., Cleveland, Ohio

Varnish Cooking With Radiant Burners

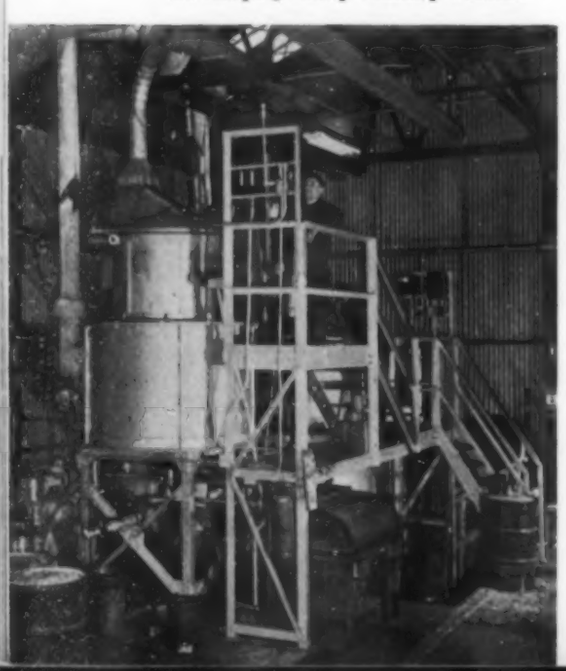
Chem. & Met. INTERPRETATION

Cooking techniques adapted for ink-making purposes may be of interest to chemical engineers because of the possibilities for process improvement wherever batch cooking is involved in the chemical, printing ink or paint and varnish industries. — *Editors.*

BETTER control, labor savings, greater production, convenience and improved plant cleanliness have been attained by the C.W.H. Carter Co. of Brooklyn, N. Y., by the use of four radiant-gas-fired kettle settings in the bodying, cooking and blending of ink varnishes and premium varnish oils.

The new facilities for processing varnish oils and transparent burnt litho varnishes went into operation last November, when a new fabricated steel building was put in service. In the new building there are four settings, all of which were designed and constructed by The Selas Co. of Philadelphia. Three are closed and the other is an open setting for the production of special burnt plate oils and Damar varnishes. All four utilize manufactured gas (525 B.t.u. per cu.ft.) automatically mixed by low-pressure proportioning-inspirator sets supplied with air at 1¼ lb. pressure. Gas is supplied to each inspirator set through a zero governor reducing the gas to atmospheric pressure before entrainment by the air. The proportioned mixture of air and gas then flows through controls to clusters of radiant refractory-cup burners which comprise the essential elements of the settings.

Cooker with bottom discharge: used for bodying heavy viscosity vehicles



In each refractory-cup burner, the mixture of gas and required air burns in a radial series of tiny flames which scrub the corrugated concavity of the ceramic cups. The cup surface temperature is thus raised to a point of brilliant incandescence which promotes complete combustion in a compact space, gives stability and speed to the combustion reaction, and develops a substantial percentage of radiant heat. Thus is insured the highest efficiency of distributed heat transfer to the kettle bottom without hot spots or flame impingement.

Setting "A" is closed, uses a cluster of 60 Selas hexagonal Duradiants arranged in four concentric hexagonal rings, carries a large stainless steel kettle and has a welded steel casing 6 ft. in diameter, lined with 4½ in. of insulating brick and 1 in. of block insulation. The burner cluster is so arranged it may be lowered out of the setting as a unit from below. All three closed settings are equipped with electric spark ignition for igniting a gas pilot which lights the burner nest. The system is protected by a safety device which automatically shuts off solenoid valves in both main and pilot fuel supply lines in the event of pilot flame failure. Temperature control is essentially manual although indicating pyrometers and air-gas mixture pressure gages as well as "limitrol" devices are installed. The setting accommodates 15-drum batches and is principally used for bodying linseed stand-oils and litho-varnishes at temperatures up to 625 deg. F. With the negligible heat retention of this type of setting it is possible to cut off all heat input to the kettle instantly enabling precise control of the ultimate batch viscosity.

Setting "B" is smaller and handles 5-drum batches. It uses a cluster of 26 gas burners in three concentric rings and has a centrally located bottom outlet from the kettle. This outlet pipe goes directly through the center of the burner cluster with a special refractory sleeve and permits batch removal by gravity flow rather than by pumping. This is important because the setting is principally used for bodying only the heaviest viscosity vehicles.

Setting "C" is also closed. It accommodates a 75-gal. kettle and is principally used for compounding drying oils with various synthetics, for blending, and for producing non-scratch specialties in reasonably small quantities. A 36-cluster of radiant burners is manually controlled for temperatures generally not over 600 deg. F.

The open setting "D" also has 36 radiant burners flush with the floor level and is used for trial cooks, special formulas and the production of burnt plate oils. (Burnt plate oils are clean-wiping and grease-free oils for bank-note plates and fine copper engravings.)

Using the radiant gas settings, one man can now body 15 bbl. in less time than it previously took one man to body of 5 bbl. with coke fires. Per unit of production, over all operations, labor requirements are now ½ to ⅓ less. In addition, there is no need for coke storage space and plant cleanliness is much improved. It is estimated that the gas cost for bodying the higher production products in settings "A" or "B" amounts to about 0.45 cents per gallon. Estimates of production speeds show that kettle "A" is capable of bringing 500 gal. of linseed oil from room temperature to 630 deg. F. in less than 2½ hr. with a gas consumption of 1,400 cu.ft. per hr. Kettle "B" consumes only 570 cu.ft. per hr. which is sufficient for heating 250 gal. of linseed oil to the same temperature in the same time. The versatile kettle "C" uses 880 cu.ft. per hr. and will bring 75 gal. of batch to temperature in 30 to 40 minutes. The maximum gas consumption of setting "D" is 700 cu.ft. per hr.

All kettles are fitted with hoods connecting to fume incineration and exhaust equipment. The exhaust hood over the burnt litho ladling station is a complete structural iron shed mounted on rollers so that it can be moved out of the way except when actual cooking is in progress.

Fire hazards are much reduced by the inclosed settings which are flue-connected so that there is no connection between the combustion system and the atmosphere of the room. A simple shut-off valve is installed on all fuel supply lines to further promote fire protection.

Timesaving Ideas for Engineers

NEW TABLES SIMPLIFY CALIBRATION CALCULATIONS FOR HORIZONTAL TANKS WITH VARIOUS HEADS

RICHARD DEANE *Engineer, Rossland, B. C., Canada*

CHEM & MET PLANT NOTEBOOK

(*Editor's Note:* In spite of the fact that several previous methods have been published dealing with the common problem of calibrating horizontal tanks with bulged ends, there is always room for still another method if it offers a new approach or simplifies the usually arduous calculations. The method presented by Mr. Deane does offer such a new approach, in that in a single tabulation of volumes, it offers an immediate comparison of standard heads, spherical and elliptical heads and conical heads. The table is equally useful for tanks with flat heads.)

IN AN EARLIER ARTICLE the writer presented a simple graphical method for the calibration of horizontal tanks with flat heads. (*Chem. & Met.*, Jan. 1939, p. 39). The accompanying article carries the problem farther, presenting a table of volume values in terms of percent depth vs. percent capacity (Table I), for both the cylindrical portion of any horizontal cylindrical tank, and for heads of standard dished shape, as well as spherical, elliptical and conical heads. While the great majority of horizontal cylindrical tank heads are either flat or approximately of the standard dished design, with the radius of the head equal to the diameter of the tank, some heads are intentionally elliptical, others are between elliptical and the standard dish, and still others are spherical, conical, or approximately so. The present table, therefore, can be used with a sufficient degree of accuracy to calibrate tanks with almost any type of head. If analysis of a given head reveals it to be of none of the shapes listed, a close approximation of its actual volume at various heights can be made by interpolating between the two mathematical types which it most nearly approximates.

The standard dished head is the type for which most of the calibration methods have been worked out in the past. Some handbooks carry extensive tables which, however, in use require rather lengthy computation. Elliptical, spherical and conical heads seem to have received little attention, although C. A. Lee (*Chem. & Met.*, Feb. 1941, p. 137) has presented a method which is adaptable to the calibration of any type by means of a step-integration device. Lee's method was worked out primarily to deal with tanks having heads with radii either larger or smaller than the tank diameter, and hence of non-standard dished design. It would seem to be equally suitable, however, for other shapes, combining as it does a graphical approximation of the horizontal area of the heads at various levels, with a summation of increment volumes in small steps up to the half-full tank level.

The present tabulation for the standard dished head was computed by the writer by a step-integration method, since it was not found possible to obtain a function for the volume of the head at a given depth. The calculation involved taking the horizontal area within the head at each small interval of depth, averaging adjacent areas, and multiplying by the vertical interval. In this manner a very close approximation of the volume for each such interval was obtained. The volume of the first interval from the bottom was treated as a pyramid. The volume of the various intervals so obtained were then divided by the total volume of the head, multiplied by 100, and the resulting percents progressively summed to give the desired table.

A test of the accuracy was obtained by the degree of approximation attained as the summation approached the actual half volume of the head at 50 percent of the depth. For the dished head, the summation at 50 percent depth came to 50.0025 percent. For the cone head, which was similarly calculated, the total was 49.9980 percent. Since the tables are given to two decimal places, all figures are presumed to be accurate.

The columns in Table I for the cylindrical portion, and for the elliptical and spherical heads were taken from Marks' Handbook (Fourth Ed., 1941, pp. 35 and 38 resp.). Marks'

Table I—Percent Depth Vs. Percent Capacity for Horizontal Cylindrical Tanks with Standard Dish, Elliptical, Hemispherical and Cone Heads
(Expressions for volume of heads at top of columns are for *two* heads)

Percent Depth, $100\ h/D$	Percent Capacity				Percent Depth, $100\ h/D$	Percent Capacity			
	Cyl. Section, $V = \frac{\pi\ D^2L}{4}$	Standard, Dish Rad. = Dia. $V = 0.8041\ D^3d$	Elliptical & Hemispherical, $V = 1.047\ D^3d$	Cone Type Heads, $V = 0.524\ D^3d$		Cyl. Section, $V = \frac{\pi\ D^2L}{4}$	Standard, Dish Rad. = Dia. $V = 0.8041\ D^3d$	Elliptical & Hemispherical, $V = 1.047\ D^3d$	Cone Type Heads, $V = 0.524\ D^3d$
1	0.17	0.005	0.03	0.004	26	20.66	13.99	16.76	12.06
2	0.48	0.03	0.12	0.023	27	21.78	15.16	17.93	13.16
3	0.87	0.09	0.26	0.06	28	22.92	16.37	19.13	14.31
4	1.34	0.17	0.47	0.13	29	24.07	17.62	20.35	15.51
5	1.87	0.30	0.73	0.22	30	25.23	18.91	21.60	16.76
6	2.45	0.47	1.04	0.35	31	26.40	20.23	22.87	18.05
7	3.08	0.68	1.40	0.51	32	27.59	21.59	24.17	19.39
8	3.75	0.94	1.82	0.71	33	28.78	22.98	25.48	20.78
9	4.46	1.24	2.28	0.95	34	29.98	24.41	26.82	22.22
10	5.20	1.59	2.80	1.22	35	31.19	25.86	28.17	23.69
11	5.98	1.99	3.36	1.54	36	32.41	27.34	29.55	25.26
12	6.80	2.45	3.97	1.91	37	33.64	28.85	30.94	26.78
13	7.64	2.95	4.63	2.32	38	34.87	30.38	32.35	28.38
14	8.51	3.50	5.33	2.77	39	36.11	31.93	33.77	30.02
15	9.41	4.11	6.07	3.27	40	37.35	33.51	35.20	31.70
16	10.33	4.76	6.86	3.92	41	38.60	35.10	36.65	33.41
17	11.27	5.47	7.69	4.42	42	39.86	36.71	38.10	35.16
18	12.24	6.22	8.55	5.07	43	41.12	38.34	39.57	36.94
19	13.23	7.03	9.46	5.77	44	42.38	39.98	41.04	38.74
20	14.24	7.88	10.40	6.52	45	43.64	41.63	42.52	40.57
21	15.27	8.79	11.38	7.31	46	44.91	43.30	44.01	42.43
22	16.31	9.74	12.39	8.16	47	46.18	44.97	45.51	44.30
23	17.38	10.73	13.44	9.06	48	47.45	46.64	47.00	46.19
24	18.46	11.78	14.52	10.01	49	48.73	48.32	48.50	48.09
25	19.55	12.86	15.62	11.01	50	50.00	50.00	50.00	50.00

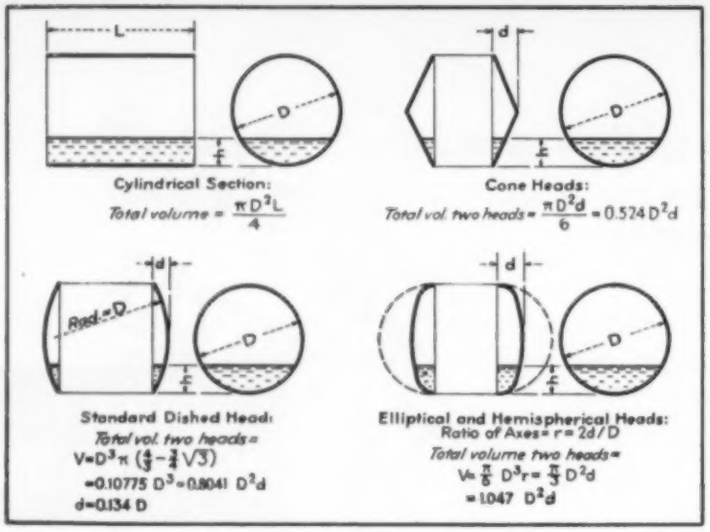

L
D
d
Cylindrical Section:
Total volume = $\frac{\pi D^2 L}{4}$
Cone Heads:
Total vol. two heads = $\frac{\pi D^2 d}{6} = 0.524 D^2 d$
Rad = D
Standard Dished Head:
Total vol. two heads =
$V = D^3 \pi \left(\frac{4}{3} - \frac{3}{4}\sqrt{3}\right)$
$= 0.10775\ D^3 = 0.8041\ D^2 d$
$d = 0.134\ D$
Elliptical and Hemispherical Heads:
Ratio of Axes = r = 2d/D
Total volume two heads =
$V = \frac{\pi}{6} D^3 r = \frac{\pi}{3} D^2 d$
$= 1.047\ D^2 d$

Fig. 1—Types of heads and their formulas

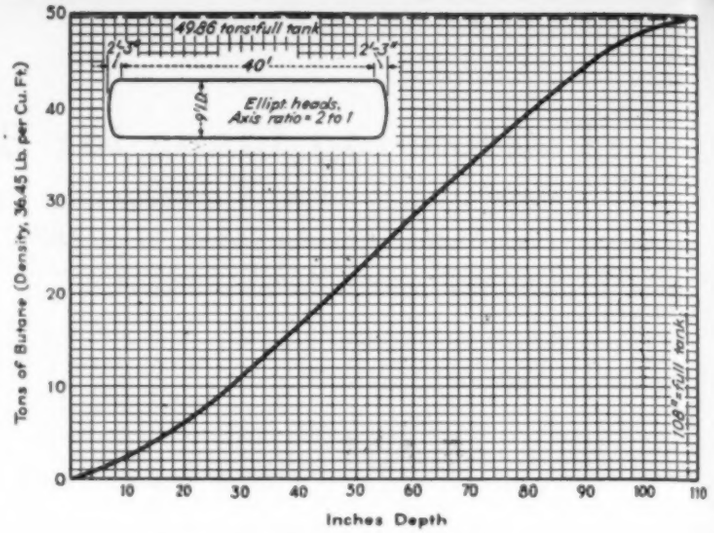


Fig. 2—Calibration for tank in text problem

tabulation on page 35 for the ratio of the area of a circular segment, to that of the circle, applies directly to the cylindrical portion of the tank. In the case of an elliptical head, it can be proved that such a head of any axis ratio has the same characteristic depth vs. capacity curve as a spherical head and therefore Marks' tabulation on page 38 of the ratio of the volume of a spherical segment, to the volume of the sphere, applies directly to both elliptical and spherical heads.

In the case of a cone head, it can be proved that the depth vs. capacity curve is independent of the central angle so long as the cone is of right, circular shape. As in the case of the standard dished head, the tabulation for conical heads was worked out by taking the horizontal area at each interval, averaging adjacent areas, multiplying by the height of the intervals, dividing each incremental volume by the volume of the head to obtain the percent of the total head volume at each height, and summing these percents progressively.

With the exception of the standard dished head, the total volume expressions given in Fig. 1 and Table I were simply calculated by evaluating the well known mathematical expressions for the volumes of the several head shapes. The expression for the total volume of two standard dished heads, namely, $V = D^3 \times \pi \times (4/3 - 3\sqrt{3/4})$, is not quite so easy to evaluate since it involves a subtraction of nearly equal numbers. It was carried out to eight decimal places in the calculation to insure accuracy.

In this connection, it should be noted that the expression for the total volume of two standard dished heads, given as $V = 0.8041\ D^2 d$, applies only to the standard head, with the head radius equal to the diameter of the tank. It does not apply to any other head radius. However, another point worth noting about this formula is that for heads which deviate slightly from a true spherical segment of $R = D$, this formula gives a more accurate volume than the alternate form, $V = 0.10775\ D^3$.

Table I, as already indicated, summarizes the data for calculating the volumes at various depths for the various types of tanks, listing the percents of the total capacity of the tank at various percents of the total depth. The second column of the table gives percents of total capacity of the cylindrical portion at various percents of total depth, while the third, fourth and fifth columns list percents of total capacity for the several types of heads noted. At the top of each column are given the expressions for the total capacity of the element covered in that column. Note that the total volume expressions for the heads give the volume of *two* heads. Note also that Table I covers only the lower half of the tank. For the calibration of that part of the tank above the mid-point, the volumes at the various higher levels are obtained by subtracting the volumes at the corresponding distances above the bottom of the tank, from the total volume of the tank.

As an example of the use of the table, consider the calibration of a horizontal, cylindrical tank for liquid butane, as shown in Table II and Fig. 2. The length of the cylindrical portion is 40 ft., the inside diameter is 9 ft., and the heads are elliptical, with an axis ratio of 2 to 1 (i.e., $d = 2$ ft. 3 in.). The density of liquid butane at 60 deg. F. is 36.45 lb. per cu. ft. Hence, the capacity of the cylindrical portion of the tank is $\pi \times D^2 \times L/4$ cu. ft., or $(9^2 \times \pi \times 40 \times 36.45)/(4 \times 2{,}000) = 46.38$ tons. The capacity of the two elliptical heads is $\pi \times D^2 \times d/3$ cu. ft., or $(9^2 \times \pi \times 2.25 \times 36.45)/(3 \times 2{,}000) = 3.48$ tons. The total capacity of the tank is therefore $46.38 + 3.48 = 49.86$ tons.

For ordinary work in making a calibration curve, it is usually sufficient to calculate the capacities for, say, each 5 percent of depth. For highest accuracy, closer calibration may be needed, but since a tank is gaged for each inch of depth, rather than for each percent, it will in any event be necessary to make a calibration curve, from which the capacities at each inch of depth can be read off if a tabulation is to be made. The calculations for the butane tank are shown in Table II, for each 5 percent of depth. A calibration curve drawn from these data is shown in Fig. 2. With care in the calculation and curve drawing, such a curve will be accurate enough for most purposes, and can be read off to permit the listing of capacity values for each inch of depth. It should be observed, however, that when the calibration is in terms of weight rather than volume, as in the example given, a temperature correction factor may be necessary when measurements are made at temperatures other than that for which the calibration was made. This is true in the case of butane which has a considerable expansion coefficient.

Table II—Calibration of Butane Tank as Described in Text

Percent Depth	Depth, in., % Depth × 108 in.	Tons Capacity: Cyl. Section, % Cap. × 46.38	Tons Capacity: Two Heads, % Cap. × 3.48	Total Tons at Percent Depth
5	5.4	0.87	0.03	0.90
10	10.8	2.41	0.10	2.51
15	16.2	4.36	0.21	4.57
20	21.6	6.60	0.36	6.96
25	27.0	9.07	0.54	9.61
30	32.4	11.70	0.75	12.45
35	37.8	14.47	0.98	15.45
40	43.2	17.32	1.22	18.54
45	48.6	20.24	1.48	21.72
50	54.0	23.19	1.74	24.93
55	59.4		49.86—21.72	28.14
60	64.8		49.86—18.54	31.32
65	70.2		49.86—15.45	34.41
70	75.6		49.86—12.45	37.41
75	81.0		49.86— 9.61	40.25
80	86.4		49.86— 6.96	42.90
85	91.8		49.86— 4.57	45.29
90	97.2		49.86— 2.51	47.35
95	102.6		49.86— 0.90	48.96
100	108.0		Full tank	49.86

CHEM & MET REPORT ON

Electronic Devices For Process Control—II

TO CHEMICAL ENGINEERS, SUPERINTENDENTS AND PRODUCTION EXECUTIVES

Electronic tubes and photocells have already made an enormous impact on communications, television and sound reproduction. What is not so well known to many engineers is the fact that these devices are beginning to take an important place in industry applications, including measurement and control, and the handling and conversion of electric currents. For many purposes they furnish a better answer than any other means to the problem of speeding up operations and improving processes, so necessary in these critical days. Last month *Chem. & Met.* presented the first of two reports on this important subject, written by a well known authority in the field of industrial applications. The earlier article dealt with the fundamentals of those devices used in control. The present paper is concerned with their industrial uses, and also with several of the more complex varieties, for measurement and current handling.

CHEMICAL AND METALLURGICAL ENGINEERING · APRIL, 1942

Electronic Devices For Process Control—II

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Chem. & Met. INTERPRETATION

This is the second of two *Chem. & Met.* Reports on the subject of electronic devices, their principles and applications to process control. The first report, which appeared on pages 99 to 106 of the March issue, explained the operation of such equipment and described a considerable number of types of both thermionic tubes and photoelectric cells. This report goes somewhat farther in explaining the principles of certain more specialized types which are used primarily for rectification of power, for inversion of direct to alternating currents, and for direct measurements of electrical quantities, pH, light, opacity and color values. It also covers briefly a number of types of application, of which many are current, in which the electronic equipment is used primarily as a switch or relay for counting, measurement and control of many factors.—*Editors.*

In the first part of this article (*Chem. & Met.*, March 1942, pp. 99-106) it was pointed out that electron tubes are classified into two groups: (1) Photoelectric cells, in which a flow of electrons is brought about or controlled by the action of light for the purpose of controlling some useful mechanism; and (2) non-photoelectric electron tubes, in which electrons are emitted from a surface within the tube without light impingement, also for the purpose of controlling a useful mechanism. To make it easier to visualize some of the ramifications of these two general types, Fig. 1 is presented, giving in simplified form an outline of the principal types and their general fields of application.

Referring to the non-photoelectric types, the first article explained that in general, high-vacuum tubes are employed for rectification, amplification, generation of alternating currents (oscillators), measuring, and as relays. Gas-filled tubes, in general, are used for rectification, generation of direct current (inverters), and as relays. The fundamentals underlying the operation of both high-vacuum and gas-filled tubes were explained.

This second article has a two-fold purpose: First, it goes somewhat farther into some of the more specialized tube types, particularly those which are used for industrial purposes other than control, such as rectification and inversion of currents, and the direct measurement of certain quantities. Its second purpose is to describe a number of the commoner applications of the less specialized tubes and photocells.

There has been a certain amount of confusion in the study and application of electronics, since tubes may be described in at least three ways: (1) By function; (2) by construction; and (3) by a trade name. Certain of the trade names are so commonly employed that any confusion on this score should be cleared up here and now so far as this discussion is concerned. The following definitions deal only with non-photoelectric tubes. In the high-vacuum class there are two well-known types which are often referred to by trade names. The Kenotron is defined as a high-vacuum thermionic tube in which no means is provided for controlling the uni-directional current flow. Such tubes have two elements and are used solely for rectification. The Pliotron is a high-vacuum thermionic tube which in addition to an anode and cathode has one or more electrodes for controlling the uni-directional current flow. Such tubes are used as amplifiers, oscillators, measuring devices, relays, and for similar purposes. A variety of other names, some generic and some trade names, are applied to this class of tube including Radiotron, radio tube, Thermion, tetrode (four electrodes), triode (three electrodes), and Oscillion.

As the first article explained, there is an important fundamental difference in the characteristics of high-vacuum, and gas- or vapor-filled electronic tubes, owing to the process of gas amplification which occurs in the second class. Consider the comparative character of rectifiers of the two types: In either type plate current can flow, of course, only when the anode is positive. In the high-vacuum type the amount of current that flows is dependent on the difference in potential of the anode and cathode and so, for any applied potential, the more electrons there are, the more current can be carried, consistent with the heat dissipating abilities of the tube. In a high-vacuum rectifier a considerable voltage drop exists across the tube, which decreases the available voltage across the output terminals of the rectifier.

On the other hand, when an inert gas is present in the tube, or a vapor such as mercury, the collisions of the electrons with the gas or vapor molecules produce new electrons and materially augment the electron stream flowing from the cathode to the anode (gas amplification). The number of electrons flowing continues to increase as the voltage is raised until a point is reached where the current in the gas space rapidly increases to some ultimate value at the "break-down" or glow point of the tube. When this has occurred, the current through the tube is limited only by the resistance of the circuit, and the tube is illuminated with a glow characteristic of the gas or vapor filling. Many times the current can be carried that can be passed by an equivalent high vacuum tube. Furthermore, voltage drop in the tube is low, and a greater external rectifier voltage is available across the output terminals of the tube. Fig. 2 illustrates the relations between rectifier current and applied voltage in the two types of tube.

The gas- and vapor-filled groups of tubes comprise three general classifications including: (1) The cold-cathode type; (2) the hot-cathode type with filament-heated cathode; and (3) the mercury-pool type employing arc discharge.

1. The cold-cathode tube was not mentioned in the first article since it has relatively little application in the field of industrial control. Very briefly, a tube containing a gas or vapor at low pressure will contain a number of free ions and electrons and if a potential difference is applied between the electrodes, the tube will become conducting by the process of gas amplification. In such a tube either electrode (since neither is heated) can serve as the anode, depending upon the direction of polarity. If a third element, similar to a grid, is added to serve as a starter, this grid can be biased more negatively than a certain critical value (depending on the plate potential), and thus prevent what few electrons originally are present from reaching the anode. Such a tube is extremely

sensitive to slight grid potential changes; even bringing one's hand near the grid connection is sufficient to cause the tube to break down and produce a glow discharge.

2. Hot-cathode tubes of the gas- and vapor-filled variety, like the high-vacuum type, are divided into those tubes with but two elements, and those with three or more. Among the two-element type are the three well-known trade names of Tungar and Phanotron (G.E.) and Rectigon (Westinghouse). Gaseous tubes having one or more additional electrodes for the purpose of controlling or starting the flow of uni-directional current include the well-known Thyratron type. These tubes are used as high capacity current contactors, relays and as inverters.

3. Tubes of the mercury-pool type have in recent years become extremely important as industrial rectifiers. Included in this type are the older mercury-pool rectifiers employing a continuous arc as a "keep-alive" mechanism. An industrial modification of this early type is the tank-type multi-anode mercury-arc rectifier. A more recent development is the Ignitron mercury-arc rectifier developed by Westinghouse and now also manufactured by several other concerns.

Mercury-pool type tubes may be built either with or without control grids. The use of a control grid, as in tank-type multi-anode rectifiers and in Ignitrons, makes possible control of the point in the voltage cycle at which the tube becomes conducting and hence permits accurate regulation of the quantity of current flowing.

INDUSTRIAL RECTIFIERS

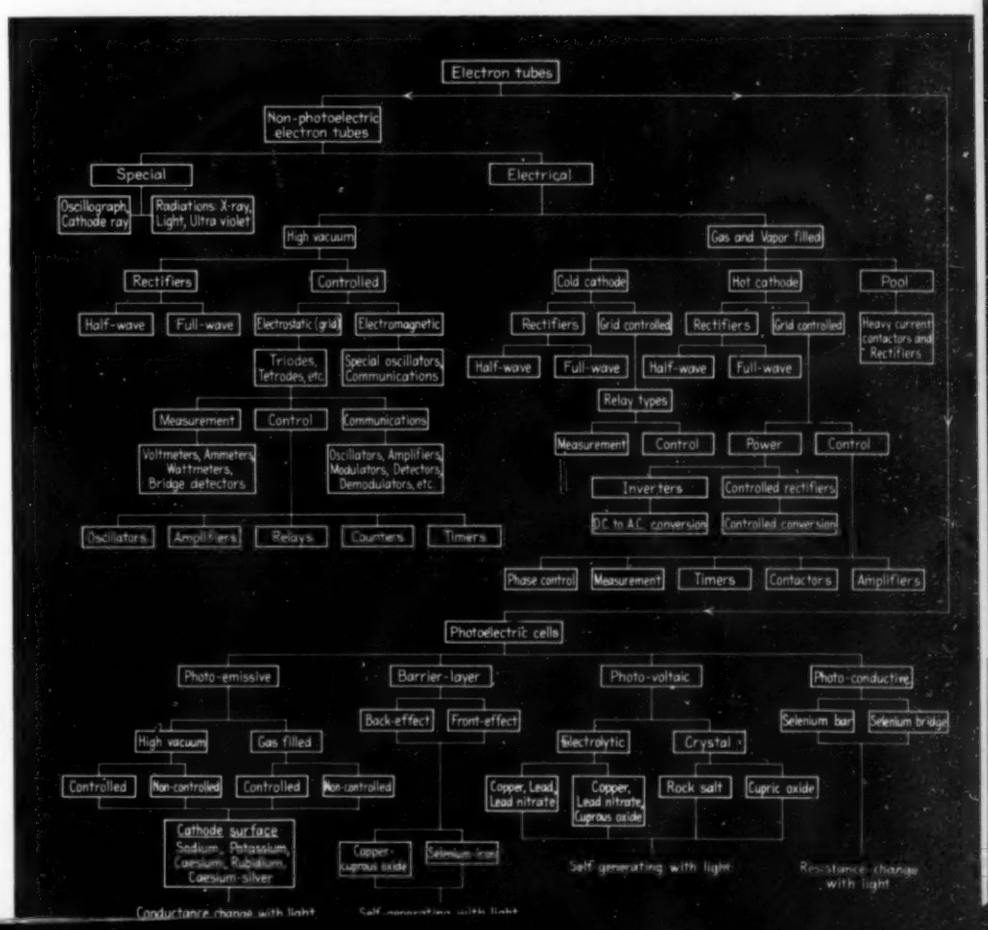
Large capacity mercury-arc rectifying devices are important industrial tools, particularly in electrochemical industries. In recent years, the tendency has been away from motor-generators and synchronous converters for this purpose, and toward the more efficient mercury-arc devices. The first of these, the steel-tank, multi-anode rectifier, was introduced from Europe shortly after the last war and gained commercial importance about ten years later. The arc rectifier was rather slow in being introduced to electrochemical uses because of its considerable voltage drop (25-30 volts), which made it relatively inefficient except at high voltages (600 volts). This difficulty was to a large extent overcome with the development by Westinghouse in 1937 of the Ignitron rectifier, a type of mercury-arc rectifier in which each anode and cathode pair are individually inclosed in an evacuated steel chamber, as compared with the practice of employing 6 to 12 anodes and a single mercury-pool cathode in the tank-type rectifier. Another difference is that, while the multi-anode type is continuously excited, for the continuous maintenance of a "cathode spot" on the surface of the mercury, in the Ignitron this cathode spot is permitted to go out at the end of each positive half of the cycle (conducting portion of the cycle) and then is re-ignited by means of a high-resistance ignitor rod dipping in the mercury, when the cycle again becomes positive. This construction permits the anode and cathode to be placed quite close together so that the arc voltage drop is small.

The Ignitron is the type of rectifier being employed in the new aluminum and electrolytic magnesium installations. It operates on a basically new principle which permits a closer approach to the theoretical efficiency of the mercury arc than any other type of rectifier tube. The Ignitron at present is the most efficient method of producing direct current by rectification. As shown in Fig. 3, it consists essentially of a metal chamber cooled by water circulation. In the lower portion of the chamber is a mercury pool into which dips a high-resistance ignitor rod of a suitable refractory material, such as silicon carbide or boron carbide. An anode suspended in the chamber above the mercury is suitably insulated from the vessel with a vacuum-tight insulating bushing. Starting is accomplished by passing a current between the high-resistance rod and the low-resistance mercury pool. When this is done a small spark occurs at the junction, at a definite value of voltage and current, producing what is termed a cathode spot which liberates sufficient electrons to initiate electron flow to the positively charged anode. This process requires less than 25 micro-seconds. When the anode becomes negative during the succeeding portion of the alternating current cycle, the discharge ceases. Thus the Ignitron is extinguished every half cycle. The illustration shows a grid which has been added for current control.

The Ignitron principle makes possible practically unlimited emission and therefore extremely high overload capacity. As the mercury is vaporized from the pool, it condenses upon the cold surface of the Ignitron shell and runs down again, replenishing the pool. The life of a pool cathode is many times longer than that of a hot-cathode or thermionic type rectifier. To insure high efficiency, water cooling is necessary in the larger units and generally continuous vacuum pumping as well.

For full-wave rectification, two Ignitrons are used, one rectifying each half of the wave. For three-phase rectification, three units are used for each half wave, or a total of six. Because the arc is extinguished every half cycle when the anode becomes negative, and since the source of ionization is eliminated during this half cycle, the Ignitron can withstand high reverse voltages without danger of the arc-back which is relatively common in other forms of mercury rectifier. Smaller Ignitrons with glass inclosures are capable of passing single-cycle pulses up to 1,000 amp. for making spot welds at 60 spots per minute. For larger power capacity, the water-cooled metal-incased type is capable of passing single-cycle pulses up to 3,500 amp.

Fig. 1—"Organization Chart" of principal types of photoelectric and non-photoelectric devices used primarily in industrial applications



In addition to their uses in electrochemical industries, Ignitrons are now being used extensively for controlling currents in the spot welding of metals, particularly stainless steel and aluminum. In this application, a pulse of current having a large magnitude and a carefully controlled short duration must be fed into the weld. Such a hook-up is illustrated in Fig. 4, in which two Ignitrons control the current flow through the primary of a welding transformer. The system is caused to fire by some form of starter such as a pushbutton or, more frequently, by a specially set timer which completes its circuit through both ignitor electrodes and their respective cathodes. Starting arcs are formed at both cathodes and the tube whose anode is positive conducts during a half cycle. At the next half cycle the previously conducting tube is extinguished, while the anode of the second tube becomes positive and conducts for a half cycle. Because of the very low internal voltage drop, a large current can flow to the welding transformer and such flow will continue in pulses as long as the control circuit remains closed. Under these conditions the Ignitrons act as contactors which close their circuits in a matter of micro-seconds and open them positively. Only a small amount of energy in the pool circuit is required to permit control of tremendous amounts of current in the anode circuit of the Ignitron tube. Control of the pool circuit can be accomplished by small grid-controlled rectifiers, such as Thyratrons.

THYRATRONS

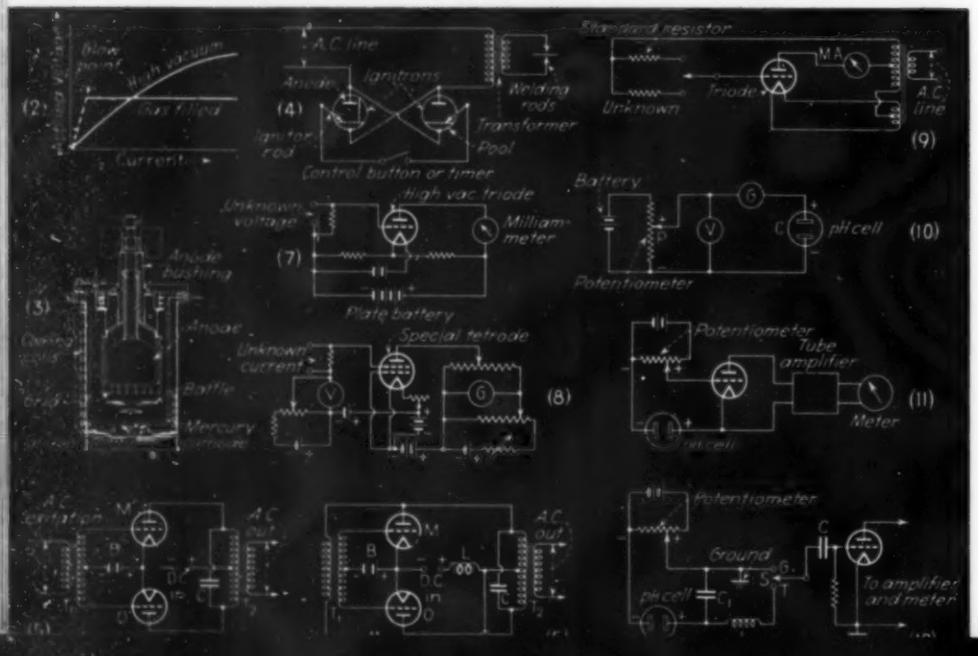
Three-electrode gas- or vapor-filled tubes with heated cathodes, of the type known commercially as the Thyratron (and sometimes called grid-controlled hot-cathode rectifiers), are becoming extremely important from the industrial standpoint. Basically, such tubes are similar in construction to the three-electrode high-vacuum tube, with the exception that in some cases they are filled with an inert gas such as neon or argon, while in other cases a mercury vapor filling is employed.

As has previously been pointed out, the gaseous tube gains tremendous current carrying capacity at the loss of linearity of response, but the response may be "triggered" so that large current values can readily be controlled. Hence, such tubes as the Thyratron have become increasingly valuable industrial tools, ranging in application from relay tubes to contactors and inverters in power transmission.

Thyratron Inverters—Broadly applied, the term inverter is any machine or mechanism capable of converting direct current to alternating current. In the past the term has been applied to arc-tube power oscillators which are capable of producing inversion but only at relatively low efficiencies. The advent of the Thyratron inverter has supplied a highly efficient apparatus for this necessary function. The Thyratron is glass-inclosed for lower power output, and metal-inclosed, usually with water cooling, for higher power output. In the larger types, Thyratrons (like Ignitrons) are kept continuously pumped by automatically controlled vacuum pumps.

Basic inverter circuits are essentially of two types. The first group, termed "external-excited inverters," are illustrated by the typical diagram of Fig. 5. The second group, termed "self-excited inverters," are illustrated by Fig. 6.

(2) Comparative current outputs of high-vacuum and gas-filled rectifiers under influence of varying potential. (3) Cross section of Ignitron rectifier. (4) Circuit using Ignitrons to control welding current. (5) Thyratron inverter circuit with external excitation. (6) Thyratron inverter circuit with self-excitation. (7) Vacuum tube voltmeter of plate detection type. (8) Vacuum tube microammeter. (9) Vacuum tube ohmmeter. (10) Potentiometer circuit for low-resistance pH cell. (11) pH cell circuit illustrating grid current error. (12) pH cell circuit employing grid current error eliminator.



External-Excited Inverters—The output of an inverter of the external-excited type (Fig. 5) is directly related in frequency and phase to the alternating current grid excitation. It will be noted that a low value alternating voltage is placed across the primary of the grid-control transformer T_1. The secondary of this transformer, which is center-tapped, is connected to the grids of two Thyratrons. A battery *B* applies a negative bias to the control grids of the Thyratrons. Hence, upon excitation by the exciting alternating voltage, one grid will be positive, while the other grid will remain negative. During the positive half cycle of grid excitation, Tube *M* will conduct, while the anode of Tube *O* is at line potential. Thus, during this half cycle, a current flows in the anode circuit of Tube *M*, through the primary of the output transformer T_2. This current flow takes place from the direct current input source which may be a direct current power line. During the negative half cycle, the Tube *O* conducts, thus lowering its anode voltage to the tube drop. Since the anodes of both tubes are connected through the condenser *C*, the anode voltage of *M* goes negative because this condenser has previously been charged and cannot discharge immediately.

The circuit constants are chosen so that the exciting ions within the tube cannot diffuse before the anode voltage becomes positive, and thus the grid of Tube *M* resumes control. When the grid of Tube *O* is made positive, and that of Tube *M* negative, the current again shifts tubes. The action is equivalent to a pair of interconnected mechanical switches which switch the direct current first in one direction through the transformer, and then in the other, at the desired frequency. This alternating switching of the two tubes continues indefinitely as long as the exciting voltage is maintained.

The switching of anode current through the primary of the output transformer T_2 produces an induced alternating voltage in its secondary. The frequency of this alternating voltage is directly dependent upon the frequency of alternating exciting voltage at T_1, which may be obtained from a small alternator or similar device.

Self-Excited Inverters—The self-excited circuit illustrated in Fig. 6 shows the original external-excited circuit converted so that the grid-exciting transformer T_1 has its primary connected to the anode supply system which contains an inductance *L* and a capacitive resistance network, C_1 and R_1. This network supplies an alternating current pulse whose frequency is dependent upon the constants of the network and the transformer T_1. This alternating current is used to supply grid excitation in a manner similar to the externally excited circuit above described. Such a circuit can supply alternating current in the frequency range from 10 cycles to well over 5,000

cycles, depending upon the constants chosen for the circuit.

D. C. Transmission—It is common knowledge that it is much more economical to transmit electricity at high voltage than at low, when a large amount of power is to be handled, owing to the smaller line losses. However, distribution problems arise in alternating current systems, both in line losses due to corona at high voltages, and in the difficulty of interconnecting systems of different frequencies. To a considerable extent it is possible to overcome these problems by the transmission of high-voltage direct current. This can be done electronically, and has been carried out on a considerable experimental scale. The method will doubtless become an important one in the future.

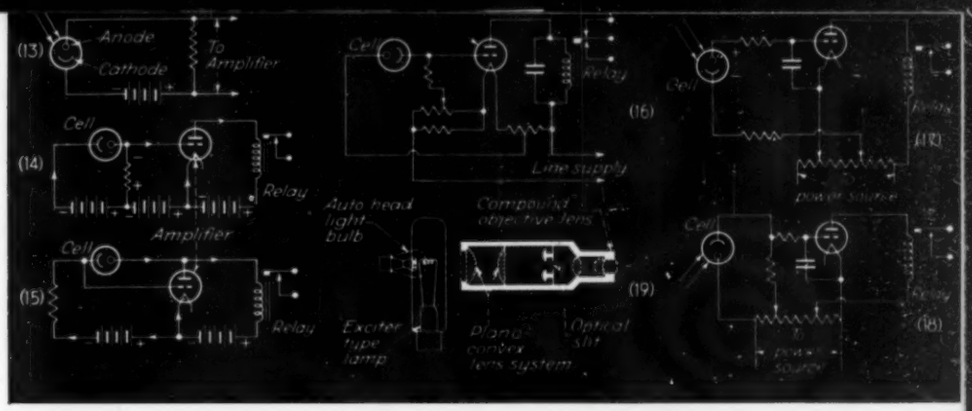
The maximum alternating current that can be transmitted is less than the maximum direct current because it is the crest of the alternating voltage wave which determines the corona loss. Also direct current transmission eliminates dielectric loss and line reactance. It is quite simple to produce high-voltage direct current from high-voltage alternating current through the use of hot-cathode and arc-discharge rectifiers. And with the Thyratron inverter it is possible to re-convert this high-voltage direct current to alternating current with good efficiency and without the need for expensive converter sub-stations. The scheme is to take low-voltage alternating current supply, step it up with transformers to high voltage, and then convert to direct current with rectifiers. The high-voltage direct current is sent out over the transmission line and at the point of use inverted to high-voltage alternating current and finally stepped down with transformers to yield the desired lower alternating voltage for distribution. Delivery can be either single- or multi-phase, and of any frequency desired. This therefore solves the problem of interconnecting alternating current sources of different frequencies and eliminates the difficulty of synchronization. Furthermore it makes available the most efficient frequency for the machinery used.

CURRENT CONTROL

In reference to the use of grids on gaseous tubes supplied with an alternating potential, it has previously been mentioned that these elements can be used to control the point in the alternating cycle at which the tube fires, and hence control the current output. Grids are used in two alternative ways, the first called amplitude control, and the second, phase control.

Amplitude control may be explained as follows: For each voltage of the anode there is a certain critical voltage of the grid which will just permit the tube to fire. If now the grid is biased negatively with a certain voltage less than the maximum critical value, this voltage will be critical for some anode potential less than the peak value that will be imposed during the alternating cycle. Hence, the tube will fire at some point before the peak of the cycle is reached, dependent on the value of grid bias. By controlling the value of the bias, the conduction of the tube can be made to start at any point in the first half of the positive half of the cycle, and thus the passage of rectified current will continue from this point until the end of the positive half of the cycle.

Phase control differs in that the bias is applied to the grid by means of an alternating voltage, which varies in phase from the alternating voltage on the anode. Hence, as the grid becomes less negative during each positive cycle of the anode, the critical voltage will be reached and the tube will fire. By shifting phase, it can be made to fire at *any* point during the positive cycle of the anode, and hence to conduct for any part of the period.



(13) Basic photocell circuit for use with amplifiers. (14) Standard photocell and amplifier circuit. (15) Photocell-amplifier circuit simplified to eliminate the cell battery. (16) Line supply photocell amplifier relay. (17) Single-tube photocell circuit which operates relay on break in illumination. (18) Single-cell photocell circuit which operates relay when cell is illuminated. (19) Special light source delivering a fine light beam.

MAGNETIC CONTROL

So far in the discussion, all tubes with grids have been controlled by electrostatic charge on the grid. One class of tube, not much used for industrial purposes, employs electromagnetic control, by virtue of the fact that electrons can be deflected by a magnetic field. When such a field is produced in the proper direction in the electron space of the tube, electrons can be prevented entirely from reaching the anode, and forced back to the cathode. Such tubes are being used in exploring the strength and direction of magnetic fields, as in a special aircraft compass.

MEASURING INSTRUMENTS

Since a three-element high-vacuum tube acts as a voltage amplifier, and can be designed for linearity of output, a group of interesting measurement applications hinges on this amplifying property. Uses of this sort fall into five classes: (1) Voltage-unbalance sensing instruments (galvanometers and electrometers); (2) vacuum tube voltmeters (electrometers, etc.); (3) vacuum tube ammeters; (4) vacuum tube wattmeters; and (5) vacuum tube ohmmeters.

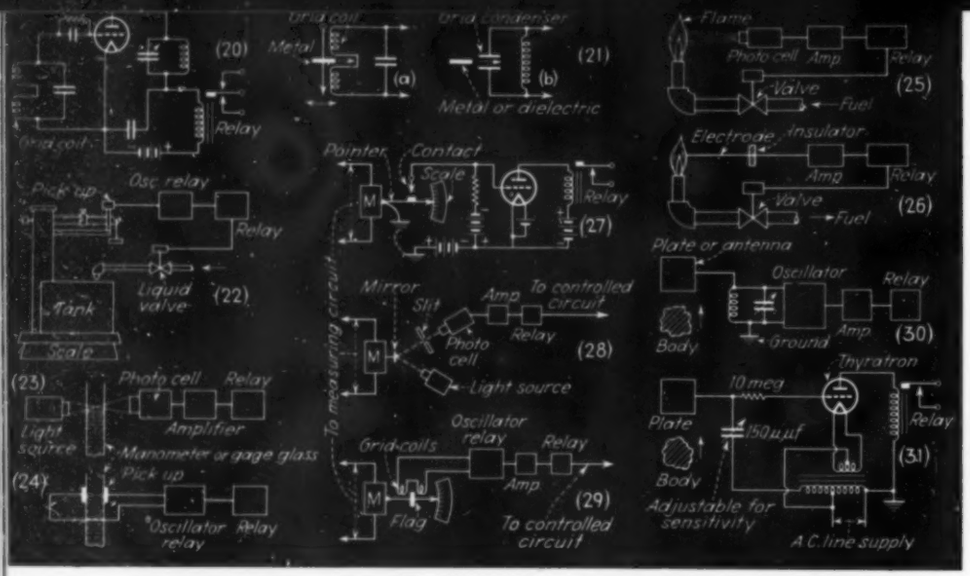
With the advent of the electronic tube, this field of measurement has been able to advance greatly in range, and many types of apparatus rugged enough for industrial use have become available where heretofore apparatus for equivalent measurement was necessarily relegated to the research laboratory. In addition to ability to measure voltage, current, power and resistance, electron tubes have been adapted to the measuring of variables such as time, speed and frequency. Still other variables such as hydrogen-ion concentration are regularly being measured in terms of voltage with vacuum tubes.

Probably the most useful of the electronic measuring instruments is the vacuum tube voltmeter. One of its advantages over the electromagnetic or electrostatic measuring instruments is the high sensitivity that can be attained in an instrument of rugged form. Its principal value is in the measurement of voltages in circuits in which the available power is so small that appreciable flow of current would measurably alter the voltage. Such measurements are involved in those of charged condensers and ion-concentration cells. This voltmeter is known in many different forms, one of the most useful of which appears in Fig. 7.

This circuit is of the plate-detection variety. A milliammeter of the D'Arsonval type, connected in the plate circuit of the voltmeter tube, is calibrated in terms of input voltage. It will be noted that as the input voltage changes, the grid bias of the tube is changed, which in turn causes a plate current change through the calibrated meter. The circuit is self-compensating against voltage variation of the batteries and against tube aging.

A vacuum tube milliammeter or ammeter is essentially a vacuum tube voltmeter designed to measure current flow by means of the drop across a high resistance through which the current flows. Special tubes have been developed for this type of application, which allow very high resistances to be used. They attain high sensitivity by limiting the external leakage present in the grid circuit of ordinary tubes. Such a circuit is illustrated in Fig. 8.

For measurement of high resistances, electron circuits have been developed



(20) Oscillator relay circuit. (21) Methods of controlling oscillator relays: (a) Flag enters grid coil; (b) Object enters grid tank condenser. (22) Oscillator relay applied to weight control. (23) Level control with photocell. (24) Level control with oscillator relay. (25) Photoelectric flame safety system. (26) Flame safety system using flame conductivity and oscillator relay. (27) Contact-making relay for instruments. (28) Photoelectric non-contact instrument relay. (29) Non-contact instrument relay employing oscillator and amplifier system. (30) Approach relay with high-vacuum tube oscillator. (31) Approach relay with Thyratron tube.

which measure such resistances in terms of grid-current flow. In the circuit of Fig. 9, the milliammeter in the plate circuit of the tube is calibrated in terms of resistance.

pH MEASUREMENT

From the standpoint of process industries, one of the most important applications of electronic tubes in the field of measurement is in glass electrode pH meters. It is not the purpose of this paper to go into pH measurement in detail (it was treated at considerable length in the *Chem. & Met.* Report for August 1940.—*Editor*). It will be worth while, however to indicate the part which the electronic tube is playing.

When a metal is immersed in a solution, the electrode potential produced is the algebraic sum of the electrolytic solution pressure and the osmotic pressure. The measurement of pH is accomplished by determining the potential between an electrode immersed in the solution, and a standard reference electrode whose potential with respect to the solution is known. Thus the unknown potential of the test electrode can be determined.

To allow the potential produced by such a cell to cause current flow through the cell, however, would cause rapid polarization of the electrode, so that the apparatus used for measuring the cell potential must be of a non-current variety such as a potentiometer, which balances the cell potential against an equal and opposite voltage drop in the potentiometer slide wire, using a galvanometer to indicate the balance point of no current flow. Since an electronic voltmeter can measure such a potential without appreciable current flow in the grid circuit, this method is available for energizing a rugged indicator.

Compared with the glass electrode for pH measurement, the earlier electrodes were considerably limited in range. However, these were generally of not over 1,000 ohms resistance, and their potentials were measurable with the potentiometer and galvanometer arrangement of Fig. 10. In this drawing the potential of the pH cell is balanced against the potential drop of the potentiometer *P*, the galvanometer *G* indicating when the potentials are equal. The voltmeter *V* can then be used to read the potentiometer drop (i.e., the cell potential). It can be calibrated in pH rather than voltage.

The glass electrode, however, is not a low resistance device and if made rugged enough for ordinary use would require a galvanometer of too great fragility, which fact brought the electron tube into use. The glass electrode is a thin bulb of special glass, into which is sealed an internal electrode dipping into an inner reference solution. The cell is completed by means of a standard calomel electrode. This combination, while not a cure-all, gives excellent results in range, freedom from poisoning and from oxidation and reduction effects. With the use of the electronic tube for measuring the exceedingly small energy output of the cell, its disadvantage of fragility is overcome, for it has been found that the cell wall resistance can be increased by many millions of ohms and still supply sufficient energy for operating the electronic meter. The apparatus used is essentially that shown in Fig. 11, employing an electron tube electrometer whose grid voltage is dependent on the difference between the potentiometer and the concentration cell potentials. The exceedingly minute energy is amplified through successive stages until sufficient energy is available for a comparatively rugged meter.

This combination of high resistance electrode and electronic meter, however, introduced new possibilities for error not formerly met. It was first necessary to eliminate leakage between the inner electrode and the immersed outer glass surface, which were at different potentials. This was accomplished by satisfactory design and sealing. The second and more important problem was to find a means of connecting the cell with the electron amplifier, which would not add the self-generated grid potential of the tube to the potential of the potentiometer. In Fig. 11 it will be noted that the grid circuit of the vacuum tube is connected directly into the circuit. The potentiometer, therefore, reads not only the potential generated by the glass electrode, but also the grid potential of the tube, thus introducing an error in measurement.

By use of specially designed electrometer tubes, self-generated grid potentials may be eliminated and accurate measurements made possible, but such electrometer tubes are expensive and fragile and are hardly applicable to a rugged industrial application. This objection has been eliminated by the development of special circuits, one of the most satisfactory of which is illustrated in Fig. 12. In this circuit, the grid-current error is eliminated by so-called impulse amplification.

In Fig. 12 it will be noted that the grid is insulated from the potentiometer circuit by a low capacity condenser *C*. The other side of *C* is normally connected to ground through a switch *S*. On depressing *S*, the condenser *C* is connected to the glass electrode. If the cell-potentiometer circuit is in balance, this point is at ground potential and no change in the condenser charge takes place in *C*. If the potentiometer is out of balance when the switch *S* contacts *T*, the condenser *C* will be charged to the difference of potential in the circuit, and the grid potential of the tube will momentarily be altered, with a consequent pulse of power to the output meter, indicating the lack of potentiometer balance. The potentiometer is then balanced correctly, using the switch *S* after each trial until no deflection occurs at the meter. The condenser *C* is made small so that its momentary energy consumption cannot polarize the electrode.

In a properly proportioned circuit, it is impossible to polarize the glass electrode, even when the potentiometer is far out of balance. Furthermore, it is impossible for the grid current to enter the measurement and upset the accuracy of the potentiometer circuit. The system is entirely independent of battery voltages or tube aging, owing to its use as an impulse amplifier. Some circuits provide an additional resistance *L* and condenser C_1 in order to make the electronic circuit independent of stray electrostatic interference, thus eliminating the necessity for lead shielding.

COLOR AND OPACITY

Photoelectric cells also are being employed extensively in measuring applications, notably in the measurement of such variables as light reflection and transmission of materials, and for the analysis and comparison of colors. This branch of electronics has become so specialized and extensive that it can only be mentioned here. In general, there are three classes of instruments for these purposes: (1) Spectrophotometers capable of producing a complete analysis of the color reflected or transmitted by a material; (2) comparators capable of determining whether two colors are a visual match; and (3) instruments which measure the intensity of light of desired wave length (or mixture of wave lengths) transmitted or reflected by a substance. In the last class are the opacity, turbidity and reflection meters. Both barrier cells and photo emissive tubes are used in the various types of instruments. Generally some method is employed to rule out the characteristics of the cell, together with other variables of the system. Otherwise a means is provided for ready recalibration in the event of changes in the system.

Some of the instruments of this group are extremely ingenious, especially the spectrophotometers. One of the latter automatically draws a continuous color curve, based on either the reflection or transmission of the sample, for the entire visible wave length range, in about 2½ minutes. Another produces a similar curve photographically in a few seconds. In spectrophotometers the illumination of the sample is supplied by a lens and prism system (spectrometer) which permits successive production of all the wave lengths of light desired. Comparators and other instruments generally use only the light produced by an incandescent filament, with or without filters.

"SWITCH" APPLICATIONS

Whereas the measurement applications just described generally employ electronic devices, directly for their *measuring* ability, there are a tremendous number of applications, well in the thousands, where the tube or photocell operates as a sensitive switch or relay, under control of a beam of light or some measuring element. In many of these applications more than one method is possible and, when feasible, parallel solutions will be given.

The applications discussed here, of course, deal only with those for industrial control. The more common ones of sound recording and reproduction, television and radio communication are entirely omitted since they have no bearing on control problems.

Fig. 13 illustrates the basic photocell circuit for use with either high-vacuum or gas-filled photo emissive cells. In this circuit it will be noted that the battery polarizes the anode of the cell through a resistor. When light falls on the cell and the cell in turn becomes conducting owing to the flow of electrons, the current flows from the anode, through the resistor, causing a voltage drop in the resistor which varies as the light upon the cell varies. As shown in several other diagrams, this voltage drop is then led to one or more amplifiers. Figs. 14 and 15 shows two ways this may be done.

In Fig. 14 the photocell is shown in series with a battery and resistor, the resistor being placed across the grid-cathode circuit of an electron amplifier. Variations in voltage across the resistor with variation in light upon the cell cause variation in the grid voltage of the tube. Flow of anode current, in turn, causes operation of the relay. A somewhat simpler circuit, shown in Fig. 15, eliminates the cell battery. In this case the anode of the photocell is polarized by the potential applied to the anode of the amplifier. A commonly used industrial photocell amplifier assembly which operates direct from the power supply lines is shown in Fig. 16. This circuit, it will be noted, is analogous to the circuits of Figs. 14 and 15. Where greater sensitivity is required, so as to operate a relay with less light, a two-stage amplifier may be employed.

Two different methods of relay operation are required in industrial practice. Fig. 17 shows a circuit designed to operate the relay mechanism when a light beam falling on the photocell is broken. This circuit is commonly employed for counters, safety devices and similar applications. Fig. 18 is a circuit used when it is desired to operate the relay of a normally dark cell when light falls on the cell. This is a common application for such problems as daylight control of signs, store lighting, road safety mechanisms, etc.

In addition to the photocell, amplifier and relay, photoelectric applications commonly require use of a light source which will project a beam of light through an appropriate lens system on to the photocell receiver and thus operate the relay mechanism. Fig. 19 illustrates the construction of a light source for producing a fine beam of light suitable for interruption by small objects, and for level control.

Not all photoelectric applications require complete interruption of the light beam, however. A change in the light intensity is the method used for detection of dust, smoke and fumes. A beam of light traversing a duct or stack falls on a photocell. Should smoke or fumes appear in greater than a predetermined concentration, the drop in light intensity can be used to operate an alarm or signal, or to control some automatic correcting means.

In most of the remaining applications to be mentioned here, both photoelectric and non-photoelectric solutions are possible. Although the former type has gained many adherents, a new type of control mechanism has become prominent in recent years, employing the oscillator relay circuit illustrated in Figs. 20 and 21. The electronic oscillator circuit illustrated in Fig. 10c of the first article of this series (March 1942) is employed in combination with an electromagnetic relay in the anode circuit. As described in the first article, the anode current of an oscillator is low if the strength of oscillation is high due to efficient feed-back. In such a case, the relay will remain open because of low anode current. If the strength of oscillation is decreased by decreasing the feed-back energy, however, the anode current increases, thus closing the relay. The feed-back energy may be decreased by changing either the inductance or the capacity of the oscillator system, or both. Hence, the anode current will increase and close the relay. Use can be made of this system in a variety of ways, several of which are illustrated in later figures. One method is to use a metal flag inserted by the function-

A Few Typical Applications of Electronic Devices

(Key: Amp., amplifier; Rect., rectifier; P.E., photoelectric; M/C, measurement and/or control; Osc., oscillator; Elect., electronic instruments)

Detecting buried pipe leaks (Amp.)
Geophysical prospecting (Osc., Amp.)
Thickness of sheet metal (Osc.)
Control of coating thickness (P.E., Osc.)
Paper mill pulp control (P.E., Osc.)
Pre-routing on conveyors (P.E., Osc.)
Synchronizing conveyors (P.E., Thyra.)
Leveling elevators (P.E., Osc.)
Elevator door guard (P.E., Osc.)
Automatic batch weighing (P.E., Osc.)
Bag piling by conveyors (P.E.)
Smoke, water hardness alarm (P.E., Osc.)
Welding current and timing (Rect., Amp.)
Traveling bed thickness (P.E., Osc.)
Limit switches for mechanisms (P.E., Osc.)
Motor speed control (Amp.)
High-speed counting (Thyra., Osc.)
Turbidity measurement (P.E.)
Color measurement (P.E.)
Color matching (P.E.)
Opacity measurement (P.E.)
Burner safety devices (P.E., Amp.)
Transparency measurements (P.E.)
Dangerous gas detection (Various)
Detecting missing labels (P.E.)
Lighting control (P.E.)
Automatic voltage control (Amp., Osc.)
Circuit breakers (Thyra., Osc.)
Telemetering (Amp., Osc.)
Synchronizing power circuits (Thyra., Amp., Osc.)
Trespass alarms (P.E., Osc., Thyra.)
Temperature, pressure, liquid level, flow, density, etc. M/C (P.E., Osc., Various)
Titration control (Amp., Osc.)
Distillation control (Osc.)
Ion concentration M/C (Amp., Osc.)
Polarigraph control (P.E., Amp., Osc.)
Interface level control (Amp., Osc.)
Saccharimetry M/C (Amp., Osc.)
Refractometry M/C (P.E.)
Contaminating gas M/C (P.E., Osc.)
Centrifuge control (P.E., Osc.)
Vacuum filter control (Osc.)
Vitamin determinations (P.E., Osc.)
Dust counting (P.E.)
Acidity, alkalinity control (P.E.)
Sorting operations (P.E.)
Bottle fillers (P.E.)
Tube fillers (P.E.)
Tank and bin level control (P.E., Amp.)
Paper mill digester control and white water recovery (P.E., Osc.)
Moisture control in sheet material (Osc.)
Stroboscopes (Grid-Glow)
Electrical quantities M/C (Various)
Rotational speed M/C (Various Elect.)
Viscosity measurement (P.E., Osc.)
Humidity control (Amp., P.E., Osc.)
High capacity contacting (Thyra.)
Current rectification (Rect.)
Current inversion (Thyra.)

ing mechanism into the grid coil of the oscillator (Fig. 21*a*), whereupon the relay contacts will operate. Another method is to change the capacity of the grid tank condenser to achieve the same effect (Fig. 21*b*). The capacity of the condenser or the inductance of the coil can be altered by moving objects. This mechanism is as flexible as most photoelectric assemblies, it is extremely simple and requires no light source.

Use of the oscillator relay of Fig. 20 is often made interchangeably in industrial applications with photoelectric apparatus. Several applications which follow may be handled either way. For example, an electronic micrometer can be made to function with either a photoelectric or oscillator circuit. In the first case an optical lever carrying a mirror will be brought to bear on the material being "miked," with a beam of light reflected by the mirror on to a photocell so that changes in thickness of the material alter the intensity of light falling on the cell. The cell output is amplified and thus operates an indicator, recorder or alarm. If the same result is to be accomplished with an oscillator, a stylus for sensing the thickness of the material can be connected to a small variable condenser used to control the plate current of the oscillator.

Other applications for both photoelectric and oscillator equipment are common in industrial weighing operations and also in liquid level control. Fig. 22 shows diagrammatically the oscillator type control applied to a platform scale beam. Figs. 23 and 24 show both photoelectric and oscillator equipment employed for liquid level control. In the photoelectric application, a change in light falling on the photo head as the level increases causes the relay to operate, while in the oscillator application a capacity pick-up placed on the gage column controls the oscillator through change in the capacity of the pick-up as the liquid level rises. Such a control may be applied equally well to a manometer tube for flow control. Still another method of level control is to use a probe inserted through the tank wall, employing conductivity as the measured factor.

Figs. 25 and 26 illustrate an important electronic application in which either photoelectric or electronic relay equipment may be used. In order to prevent the entry of raw fuel into the combustion chamber of an industrial boiler in the case of flame failure, a method of detecting the absence of flame which is capable of operating a relay to close off the fuel valve is necessary. The photoelectric type of Fig. 25 employs a photo-head sighted on the flame. The electronic type depends upon the fact that a flame is capable of conducting an electric current. An electrode contacting the flame causes a voltage change on the grid of an electronic relay. As long as the flame is present, the relay maintains the fuel valve open. Should the flame be extinguished, the conducting circuit of the electrode is broken, whereupon the grid bias of the tube changes, operating the relay and closing the valve.

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Many instruments for the indication, recording and control of such variables as temperature, pressure, flow, liquid level and pH are now employing electronic relays. Delicate instruments are disturbed in their measurement if required to do any considerable mechanical contacting work. Many ingenious contacting mechanisms based on electronic means have been developed to overcome this difficulty. Since such mechanisms can be made to function with a minute expenditure of energy, they have become increasingly important.

Systems of this type are divided roughly into two classes: (1) Contact-making systems; and (2) non-contact-making systems. The latter class includes relay mechanisms of both photoelectric and oscillator types. Fig. 27 shows an example of the first type in which it will be noted that the measuring instrument *M* carries on its pointer an extremely light contact which is placed in the grid circuit of an amplifier tube. When the contact is open the grid of the tube is negatively biased to maintain the plate current low and hold the relay open. When the contact is made, a positive bias is applied to the grid of the relay tube from the biasing battery, whereupon plate current rises sufficiently to close the relay contacts. Because of the minute quantity of energy present in the grid circuit, the contact system carries no appreciable current.

Fig. 28 shows how a similar result may be accomplished without contact, by photoelectric means. The measuring system *M* carries a small mirror which reflects a beam of light into or away from a photoelectric pick-up head whose output controls a relay through an amplifier stage. Several different methods including slits and special mirrors are used for sharp cut-off.

A second non-contact method using an oscillator relay is illustrated in Fig. 29. Here the measuring instrument pointer *M* carries a small metallic flag capable of passing into the field of the pick-up system. When such action takes place the oscillator relay changes its tuning so as to cause relay contact operation. In any of the three systems just discussed, the measuring system may be a galvanometer, millivoltmeter, microammeter or similar instrument, depending on the measuring problem.

Both photoelectric and oscillator relays are often used as limit switches in the limiting of various kinds of mechanical motion. The application, of course, is similar to level control.

Counting objects passing on a conveyor, or objects or persons approaching a given point, is another common type of application. Photoelectric counting is readily accomplished by connecting an electromagnetic counter to the relay mechanism and arranging the light source and photo-head so that each object passing interrupts the light beam, causing the relay to operate and add one digit to the counter. Such apparatus may be arranged to count one unit for every five or ten objects passing, in which case it is called a multiplying counter. Objects passing at considerable speed can be handled. Oscillator relays may be used similarly for small objects by passing the objects between the plates of a condenser in the grid circuit.

In the case of larger objects, one of several varieties of "approach relay" can be used. Such relays operate by the approach or recession of a body or mass which in most cases is a conductor. The circuit may be built around either a high-vacuum or gas-filled tube circuit. In the former case an oscillator, amplifier and relay mechanism will be used, and in the latter, a tube of the Thyratron variety. Figs. 30 and 31 show the two alternate circuits. The circuit in Fig. 30 consists of an oscillator which is tuned to resonance, as described in the first article of this series. An approach plate or antenna is connected across the oscillator inductance. Upon approach of a mass to this plate or antenna, the capacity of the antenna to ground is varied, whereupon the oscillator is detuned or retuned as desired. The oscillator consequently varies its plate current which in turn varies the bias on the grid of the amplifier and operates the relay.

Fig. 31 shows the Thyratron type of approach relay, with a plate or antenna connected to the control electrode of the Thyratron. Normally, because the control electrode is "free" (i.e., no external voltage is applied to it), an accumulation of electrons collects on the control grid, from the space charge within the tube. The electrode is therefore negative and no discharge occurs in the tube. When a body approaches the antenna, electrons leak from the control electrode to the body, permitting the tube to fire and thus operate the relay mechanism. Such systems are used for counting metallic objects passing on conveyors, as limit switches, conductivity alarms, ignition alarms, for liquid level control, for the detection of intruders and for personal safety controls about machinery.

Manifestly, this article and the one that preceded it have been unable to do more than scratch the surface of a subject which has already grown beyond the bounds of many volumes. The electronic art is a tremendous one and it is still expanding rapidly. If these pages have given chemical engineers some conception of the things electronic devices are doing, or can do for them, they will have served their purpose.

Machinery, Materials and Products

CHEM & MET PROCESS EQUIPMENT NEWS

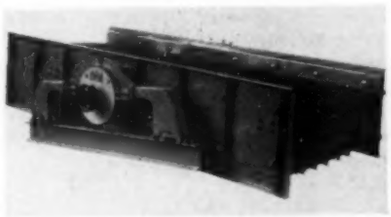
Vibrating Screen

SMOOTHER OPERATION, maximum flexibility, greater overloads and the ability to handle more capacity are claimed for the new Type M vibrating screen recently announced by Robins Conveying Belt Co., Passaic, N. J. This screen is of the high-speed type, rubber-cushioned and supported on leaf springs, with a sharp vibrating action produced by adjustable counterweighted arms. Elimination of flywheels and their high inertia, coupled with the use of oil-lubricated bearings, equipped with double bronze centrifugal flingers to prevent lubricant loss and contamination, are said to minimize power requirements. Screen cloth sections are rubber-cushioned and maintained under arched transverse spring tension. It is claimed that vibration cannot be transmitted to the building structure, while objectionable start-and-stop bounce is eliminated. Floor mounting is possible and foundation requirements minimized. Screen inclination, operating speed and vibration amplitude are all readily changed to fit the requirements.

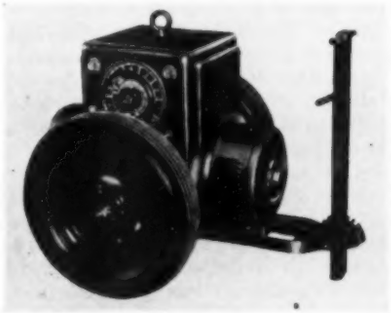
Welder Trailer

ROAD TOWING at speeds up to 35 m.p.h. is possible with the new two-wheel light weight pneumatic-tired welder trailer recently announced by Hobart Bros. Co., Troy, Ohio. This trailer, intended for the mounting of 200, 300 and 400 amp. Hobart electric drive welders, is designed particularly for hurry-up trips to different locations for emergency repair and maintenance work. Mounting is accomplished easily by means of three bolts through the trailer frame which register with three holes in the legs of the welding machine. A combination tow bar and standing support has a hand-operated ratchet for locking the support arm in position. Owing to under-slung construction, narrow tread and careful balancing, the unit may readily be moved by hand.

Type M vibrating screen



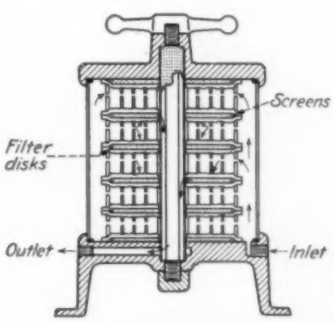
Light-weight welder trailer



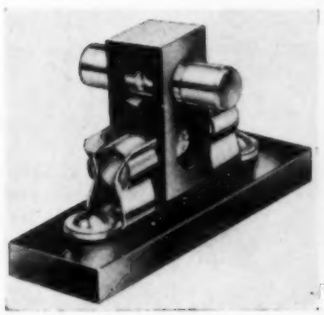
Disk Filters

A NEW DESIGN of filter known as the Sealed Disk type, intended primarily for the clarification of liquids containing relatively small amounts of solids, has been announced by Alsop Engineering Corp., Milldale, Conn. According to the manufacturer, the new design provides more filtering area in proportion to the space occupied by the filter than has heretofore been available in filters of this type. The new filter, shown in cross section in the accompanying drawing, employs throw-away filter disks composed of fibers. A single disk is formed from a large number of superimposed layers with the fibers on one side long and loosely matted, and each succeeding layer toward the other side containing shorter and more closely packed fibers. Thus the loose side can catch coarse particles while each additional layer stops finer particles. Various disk densities are available for different filtration jobs.

"Sealed Disk" filter



Fuse holder and puller



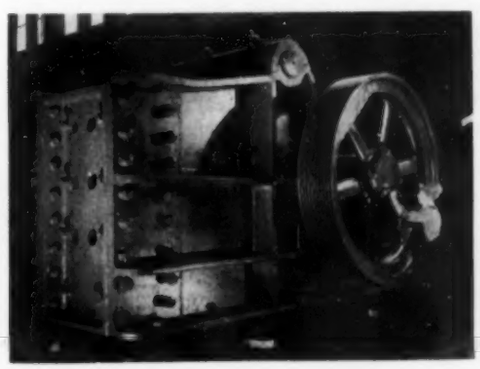
From the cross section it is evident that the liquid to be filtered enters in the space surrounding the stack of filter elements, then passes through holes in the spacing rings and flows upward and downward through adjacent filter disks. Having passed through a disk, the liquid drains through a perforated screen support to the center tube and leaves the filter. Spacing rings are of various designs, depending on the quantity of solid material (impurities, activated carbon, filter aids, etc.). In cleaning, the screw at the top is removed, after which the cover and outer cylindrical wall lift off and the individual filter elements may then be removed, the disks thrown away and replaced with new ones. Filters are regularly supplied on a supporting stand equipped with a pump and motor.

Fuse Holder

SIMPLIFYING the changing of fuses in close quarters is an important feature of the spare fuse holder and puller, recently announced by Littelfuse, Inc., 4797 Ravenswood Ave., Chicago, Ill. Adapted to all 4 AG and

New Design Jaw Crusher

The crusher shown here is a new design recently completed by Allis-Chalmers Mfg. Co., Milwaukee, Wis. Weighing about 130,000 lb., the crusher has a receiving opening 48x42 in. and is intended for crushing of extremely hard ore. This machine, one of several being built, is made with rolled-steel welded side frames to obtain greater strength and less weight, replacing the older type of crusher made with cast iron frames and reinforced by steel tension bolts.



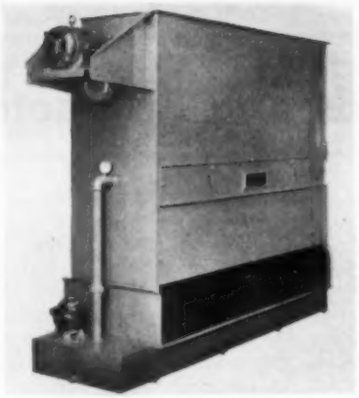
5 AG fuses, the device consists of a soft rubber rectangular holder which, as shown in the accompanying illustration, is put to use by inserting two fuses through the holes in opposite directions. The block is employed as a handle in inserting one fuse in the circuit, while the second fuse is held as a spare. When the fuse blows, the holder is then used to pull the fuse and to insert the spare in position. One end of the holder is painted red. Until a fuse change is necessary, the red end is concealed but when a reverse is made, putting the spare fuse into the circuit, the red end is brought into view to indicate to all concerned that another spare is required.

Evaporative Cooler

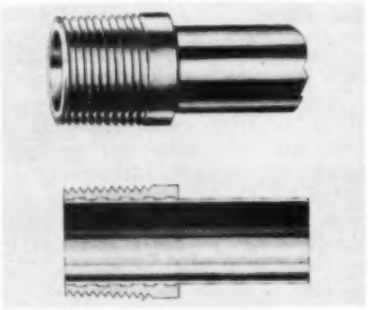
RAPID COOLING of many industrial liquids such as oils, chemicals and jacket water is possible with a new unit type evaporative cooler introduced by the Niagara Blower Co., Buffalo, N. Y. The new unit consists of a casing containing tubes through which the hot liquid passes. A spray system drenches the tubes constantly with recirculated water while air, drawn through the sprayed coils by a fan, evaporates about 5 percent of the water in producing the desired refrigeration effect. Provision is made for bypassing the air, under control of thermostatically operated dampers, to maintain constant liquid temperature. A heating coil in the liquid tank is provided for preventing freezing in winter and also for preventing the separation of high-melting-point compounds from solution. The unit is built in a variety of refrigeration capacities and is particularly recommended by the manufacturer for use where cooling water economy is necessary. It is pointed out that water consumption amounts to only about 5 percent of that required by shell and tube heat exchangers.

Tubing Joint

A NEW JOINT for thin-walled stainless steel tubing which can be used in conjunction with standard threaded i.p.s. fittings of all kinds is now being offered by Tri-Cover Machine Co., Kenosha, Wis. The Wallace joint, for the manufacture of which this company possesses an exclusive license, consists of a specially threaded enlarging ferrule which is inseparably joined to a length of stainless tubing by expanding the tubing into grooves in the ferrule. The joint can be furnished either attached permanently to tubing or separately, to be attached by the customer. No welding or soldering is necessary and the pipe may be attached to valves and fittings by simple plumbing. Owing to the high strength of thin-walled stainless tubing, it is able to replace much heavier pipes of standard i.p.s. thickness (which must be much thicker than necessary to accommodate the threads). For example, a 1¼ in. standard pipe weighs 2.717 lb. per ft. whereas the tube used with the Wallace joint to do a comparable job, weighs 0.759 lb. A saving of about 65 percent in material is said to result without loss in effectiveness. Sizes are available from ¼ to 4 in. iron pipe size, to accommodate tubing of the same nominal outside diameter.



Industrial evaporative cooler



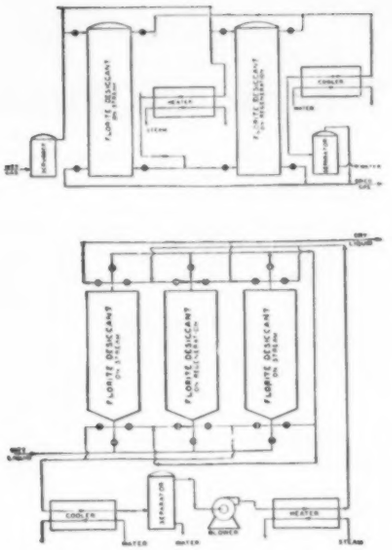
Joint for thin-walled tube

Testing Transformer

A NEW split-core current transformer for the testing of a.c. power circuits has been introduced by R. B. Annis Co., 1101 North Delaware St., Indianapolis, Ind. This transformer eliminates any need for opening a circuit to be tested, since it is only necessary to close the separable core of the transformer around the cable or buss to effect a reading. The instrument is then connected to the transformer secondary terminals. An important feature is that the accuracy of this current transformer is said to be practically independent of the tightness of closing of the magnetic core. By looping the cable through the transformer two or three times, two additional primary current ranges are made available.

Desiccating Agent

WHAT IS CLAIMED to be a suitable desiccating agent for both gases and liquids is Florite Desiccant, a new granular drying agent now being marketed by the Floridin Co., 126 Liberty St., Warren, Pa. Among the products dehydrated by this means, according to the company, are natural gas, propane, gasoline, air, nitrogen and carbon dioxide. The material is said to maintain high drying efficiency under difficult conditions, adsorbing water instantly without swelling, disintegrating or appearing wet at the end of the adsorption cycle. It is hard, stable, non-corrosive and non-poisonous, selectively adsorbing 4 to 20 percent of its weight of water, depending on the particular application. It is regenerated by heating to 300-350 deg. F. Suggested flow diagrams for the desiccation of gases (at top), and liquids (at bottom), are shown in the accompanying drawing.



Dehydration set-ups for gases and liquids

Split-core test transformer

Foam Mixing Chamber

FOR THE PROTECTION of petroleum products and other flammable liquid supplies against fire, American-LaFrance-Foamite Corp., Elmira, N. Y., has developed a new "Evertite" foam mixing chamber designed especially for installation on modern oil storage tanks of the pressure type. The purpose of the chamber is to mix the two solutions used in foam production and permit the foam to flow on to the burning oil surface in the tank. The chamber is equipped with a vaporproof glass diaphragm so installed as to prevent vapors in the oil storage tank from

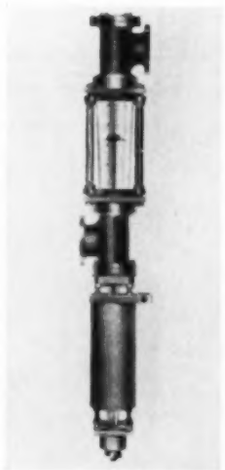
entering the body of the mixing chamber or escaping therefrom. The diaphragm, glazed in a metal frame, holds gas tank pressure yet ruptures fully under foam pressure at the time of fire, allowing free access of the foam blanket to the burning surface. Diaphragms are readily replaced. The chamber is of the expansion type with increasing cross-sectional area to provide intimate mixing of the foam chemicals and permit low delivery velocity.

Convertible Chemical Pumps

AS MANY AS 480 combinations of alloys, types and sizes, with heads and capacities to meet almost any requirement, are found in a new series of corrosion resisting pumps announced by The Duriron Co., Dayton, Ohio. Convertible features said to be obtainable only in this series of Durcopumps, which are made of the high-silicon irons, Duriron and Durichlor, permit them to be converted to stainless steel pumps simply by substituting stainless steel wet-end parts. The exchange can be made without disturbing the setting of the pump, a feature said to be especially valuable where frequent changes in process or in chemicals handled must be met.

Interchangeable Durcopump

Flow control transmitter



Other features of interchangeability include newly designed interchangeable open and closed impellers, with negative pressure on the stuffing box. The pumps feature over-sized ball bearings throughout, and micro-adjustment of the impeller for maximum operating efficiency.

Rotameter Controller

COMBINATION of electrical transmission of the flow indication, with pneumatic control of the flow, is featured in the new Rota-Matic flow controller recently announced by Fischer & Porter Co., Hatboro, Pa. The indicating instrument consists of a Rotameter flowmeter, the sensitive element of which may be either of conventional type, or may employ the company's new Ultra-Stablvis float which is unaffected by changes in viscosity of the liquid metered. Connected to the float is a soft iron armature which is positioned by the float in the coils of a self-balancing induction bridge beneath the metering tube. A similar pair of impedance coils in the receiving instrument causes the receiving armature to be positioned similarly to the sending armature, and hence adjusts the indicating pen or pointer of the receiver.

The pen arm is so connected with a control index arm that if the two are not in identical position in respect to the indicator scale or recorder chart, a flapper is moved nearer to or farther from a fixed air nozzle, resulting in changed air pressure within a bellows type control system. This in turn results in a change of air pressure on the diaphragm motor valve installed in the pipe line being controlled. The bellows control mechanism has a 0–150 percent throttling range adjustment and an adjustable reset mechanism.

The receiving instrument may be of either indicating-controlling, recording-controlling or recording-integrating-controlling type. Two instruments may, if desired, be mechanically coupled together for ratio control of two flows. Time cycle variations of the control point are also possible. Visual flow rate indication at the Rotameter can be used for manual control in event of power failure. The instrument is built in suitable construction materials for handling a wide variety of materials of both high and low viscosity, ranging from acids, tars and organic liquids to caustics and other chemicals.

Viscosity-density recorder

Three-roller jar rolling machine

Viscosity Recorder

EMPLOYING a new recording instrument recently introduced by the Petroleum Instrument Corp., 738 East 3d St., Los Angeles, Calif., it is possible to make accurate continuous measurements of both viscosity and specific gravity of liquids. Originally designed for measurements on fluids used in drilling oil wells, the instrument has been adapted for employment in many other industries. The continuous record is recorded on a 12-in., 24-hr. chart, with viscosity in centipoises and gravity in units as desired. The viscosity measuring element is a smooth cylindrical solid metallic rotor, revolving at constant speed in the liquid and turning inside a cage which contains six stationary blades. The motor torque is a measure of the viscosity, which is transmitted to the recording mechanism. Furthermore, the rotor is suspended on a weighing mechanism so that the buoyant force of the liquid, which is proportional to the specific gravity, is also transmitted to the instrument in terms of liquid density. Features include light weight, simple design, rugged construction, operation from an ordinary lighting circuit, and ease of calibration against water.

Jar Rolling Machine

FOR BATCH GRINDING and mixing of process materials of all kinds, Abbé Engineering Co., 50 Church St., New York, N. Y., has developed a new line of jar and bottle rolling machines built in a variety of sizes and types. In its simplest form, the machine consists of two parallel rubber-covered steel rollers, mounted in large bearings and driven by means of a geared head motor, the assembly being mounted on a welded steel base. Jars or bottles of various sizes can be placed on the rollers and turn as the rollers turn.

One design employs three parallel rollers for two lines of bottles or jars. Another is a double-decked model with four rollers arranged in two tiers, capable of handling eight 2.75-gal. jars.

Equipment Briefs

INCREASE in combustion efficiency in boiler furnaces is claimed by Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass., when its new photoelectric smoke alarm Type A 25C is employed for indicating the degree of smoke density passing through the stack. The equipment includes a photoelectric control, light source and indicator. The photoelectric control and light source are mounted on opposite sides of the flue or stack, so aligned that the light beam, falling on the photoelectric cell, is modulated depending on smoke density. The design of the lens system mounting is said to minimize effects of soot and dust. The indicating equipment may be located at any point to facilitate observation by the operator. A green signal light indicates efficient combustion, while a red light indicates excessive smoke density passing through the stack.

C M METEOR is the designation of a new line of heavy duty electric hoists announced by Chisholm-Moore Hoist Corp., Tonawanda, N. Y. The hoist is compact and designed to eliminate excess weight. Cooling fins are provided for quick dissipation of heat generated by gears and load brake. Construction is fully inclosed and weatherproof, with a specially designed electrical system which permits only 110 volts to pass through the pushbutton station. Sizes range from ½ ton capacity, up.

MANUFACTURE of reclaimed rubber V-belts has been announced by B. F. Goodrich Co., Akron, Ohio. These belts are claimed to give 80 percent of customary service without requiring any crude rubber. Thus, unless additional rationing of reclaimed rubber is required, the company believes that these V-belts will continue to be available for the multitude of uses to which V-belts are now being put.

TO FACILITATE attachment of its air-motored agitators to 30- and 50-gal. drums, Eclipse Air Brush Co., 400 Park Ave., Newark, N. J., has developed two sizes of V-shaped brackets which clamp across the top of the drum by means of a screw clamp which allows for variations in drum size. The mixer, attached to the bracket, can be adjusted to any angle.

Carbon Monoxide Recorder

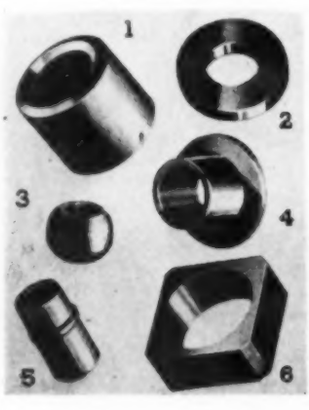
AN IMPROVED carbon monoxide recorder, available either for high sensitivity or wide range, has been developed by Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa. The new instrument is a refinement of the company's original carbon monoxide recorder. It consists of a dryer, analyzer and potentiometer recorder. Range and sensitivity can be varied to suit the conditions. If sensitivity is of primary importance, the instrument is calibrated to cover a range from 0 to 500 p.p.m., permitting a sensitivity of 1 p.p.m. When a wider range is needed the instrument is designed to cover a range from 0 to 2,000 p.p.m., permitting a sensitivity of 4 p.p.m. Both ranges can be provided in the same instrument, by providing two calibrations. This sensitivity is said to be about ten times greater than that of the most refined analytical determination.

In operation a motor-driven pump draws a sample continuously from the point of sampling and forces a part of this sample through the dryer and then through an analyzer employing a "Hopcalite" cell. Carbon monoxide in the sample is oxidized to carbon dioxide with the liberation of heat proportional to the amount of CO present. The heat liberated is measured by thermocouples imbedded in the "Hopcalite" and the resultant current is measured by the recorder potentiometer, indicating on a chart as percent CO. Up to six contactors can be provided on the potentiometer to operate valves, ventilation controls, or warning signals.

Porous Iron Bearings

SAID TO BE stronger than porous bronze bearings, a new line of porous iron bearings which are interchangeable with comparable bronze bearings, in most applications, has been introduced by the Keystone Carbon Co., 1935 State St., St. Marys, Pa. The new Selflube porous iron bearings are made of powdered iron, molded to size, in the shape desired, then baked and finally saturated with lubricating oil. Having an average porosity of 25-35 percent, these bearings hold sufficient oil to last, in many cases, for the entire life of the application. A low coefficient of friction, combined with self-lubrication, is said to prevent excessive temperature, speed reduction, noise and scoring of shafts. The accompanying illustration shows a variety of types including (1) sleeve or plain cylindrical bearing, (2) washer or thrust bearing, (3) spherical or self-aligning bearing, (4) flanged bearing, with special shapes shown at (5) and (6).

New porous iron bearings



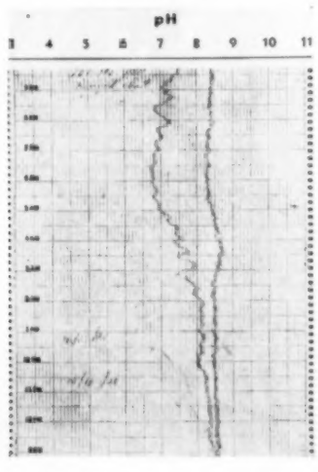
Stainless Steel Tubing

A NEW, closely controllable electric welding process is now being used in the production of stainless steel tubing by Globe Steel Tubes Co., Milwaukee, Wis. This process, developed after a long period of research and experiment, is said to produce tubing of high strength and corrosion resistance, and uniformity of structure. The process welds the stainless strip with a minimum of "flash", hence minimizing work in producing a smooth-finished tube. The weld metal structure is said closely to approximate that of the tube. It is claimed that the new tubing can be readily bent, coiled, swaged and formed. Marketed under the name of "Gloweld", it will soon be available in a wide range of diameters and wall thicknesses, in practically all stainless steel analyses.

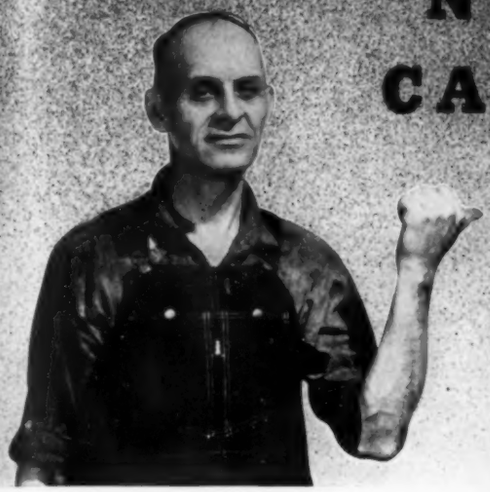
Multi-Point pH Recorder

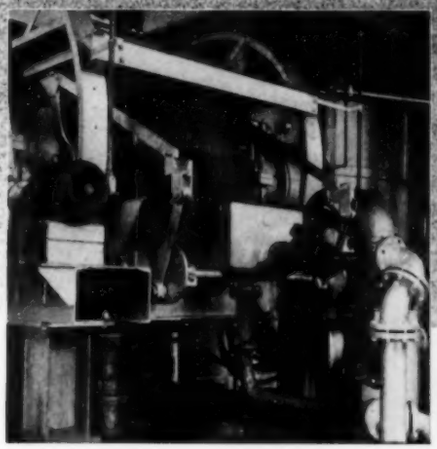
TO PERMIT the recording of pH from separate and independent points in a fluid-flow system and thus enable the operator to see continuously the before-and-after picture of the pH as it responds to the treatment used, Cambridge Instrument Co., 3732 Grand Central Terminal, New York, N. Y., has developed a multi-point pH recorder incorporating a new advance in circuit design. The accompanying illustration shows an actual record from the condensate system of a large steam-generating plant where the multi-point control is used in observing the effect of treatment to eliminate turbine blade deposits. Many other types of use of multi-point instruments are suggested, among them being applications in the brewing, pulp and paper, and oil-refining fields as well as in sugar refineries and in water treatment.

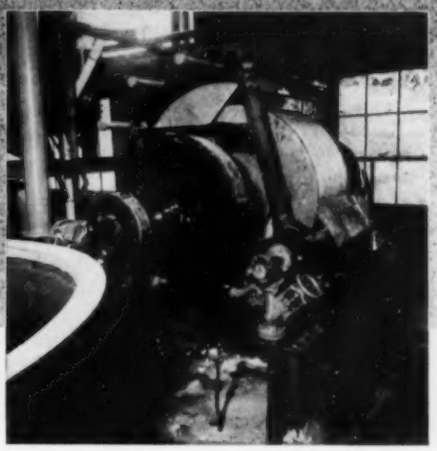
Two-point pH record



"Corrosion Problems? Not with SWENSON CAST LEAD FILTERS!"





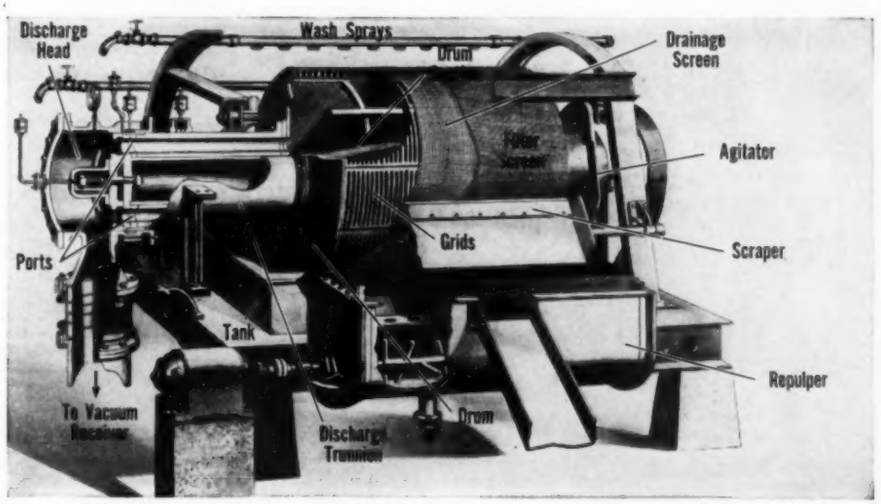


"The development of Swenson cast lead filters has certainly been a life saver for us in handling corrosive liquors. The use of cast and heavy sheet lead in the construction of these units means that they are exceptionally satisfactory in resisting corrosion. As a result, we have less interruptions to our processes, less repairs, lower maintenance charges, and lower operating costs.

"Not only that, but the rotary drum design gives us high capacities. Cloth blinding is practically eliminated, the filtrate is clear, and the cake uniform and easy to wash. These are the reasons why we prefer Swenson cast lead filters."

Swenson cast lead filters have proven remarkably successful in handling Glauber's salt, zinc sulphate, copperas, etc., from acid solutions.

The simple mechanical construction of the lead type rotary drum vacuum filter and its resistance to corrosion greatly reduce maintenance costs.



The main foundation is of heavy sheet lead. Grids and discharge head are of cast lead. Filter screens may be of Monel metal, stainless steel, or perforated rubber. Some of the external parts are constructed of rubber-lined steel.

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SWENSON

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Smokeless Powder

WHEN PEACE COMES to a country the smokeless powder industry has the unusual habit of almost entirely vanishing for the duration. However, when trouble appears on the horizon great smokeless powder plants reappear as vegetation does in the spring of the year. Already they are to be found scattered over the country.

The base of smokeless powder is nitrocellulose made by nitrating cellulose. Wood or cotton linters are used as the source of the cellulose. Purified cellulose is conveyed to the nitrating house where it is charged into dipping pots along with acids. After dipping the contents is dropped into the wringer and from there into the immersion basin, drowned with water and flushed into slurry tanks. Impurities are removed in the boiling tub procedure. After the boil is complete, the material is run out of the tubs and into another intermediate slurry tank. Any free acid is neutralized with sodium carbonate. Final neutralization is accomplished in the poacher house by addition of more carbonate. Boilings, settlings, decantations, and rewaterings follow, and the residual carbonate and salts are removed by cold water washes. Each high-grade and pyro poacher charge is analyzed and then pumped to huge vats with umbrella baffles and agitators in the blending and wringer house. Blending produces the desired nitrogen content.

The product is now ready for the smokeless powder area. The first action is the substitution of alcohol for water in the powder. The mass is pressed leaving enough alcohol to satisfy the colloidizing action in the mixers. Here blocks are broken and partially mixed with insoluble compounding agents and then ether, containing a stabilizer and plasticizer, is added. In the case of cannon powder the colloidal formation is completed in macerators, then blocked in presses for convenience in handling. It is screened and pressed into strings and cut in desired lengths. Solvents are removed and recovered. The powder is blended, weighed into containers which are then sealed, air-tested, stenciled, and routed to shipping and storage departments.

CHEMICAL & METALLURGICAL ENGINEERING

April, 1942

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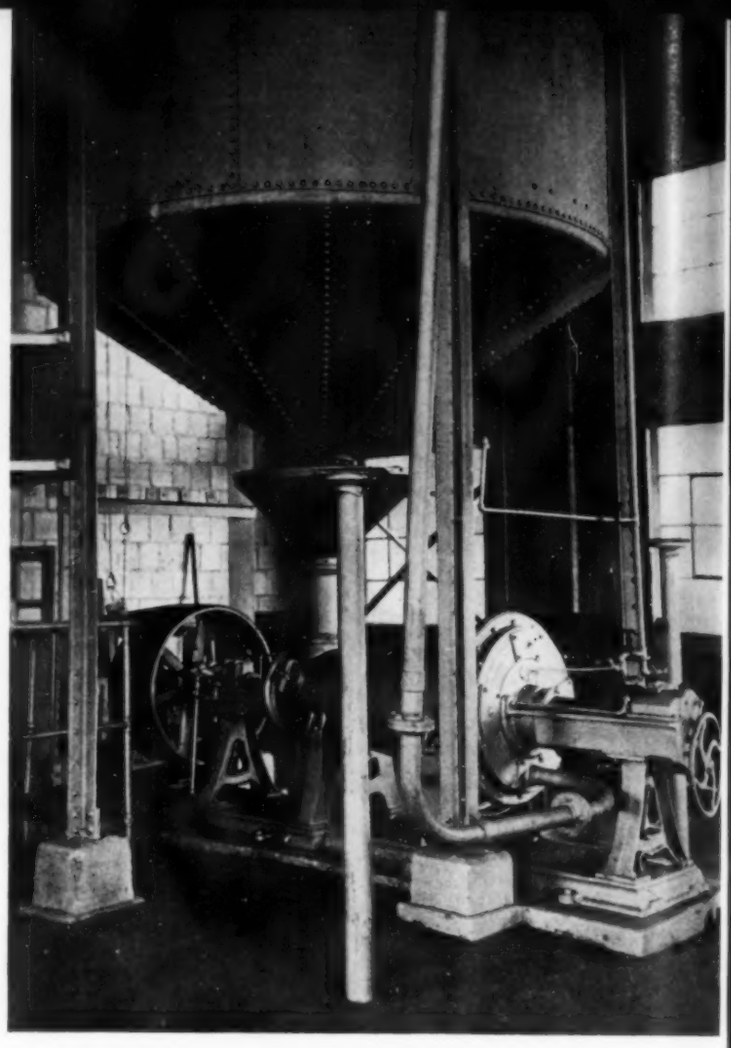
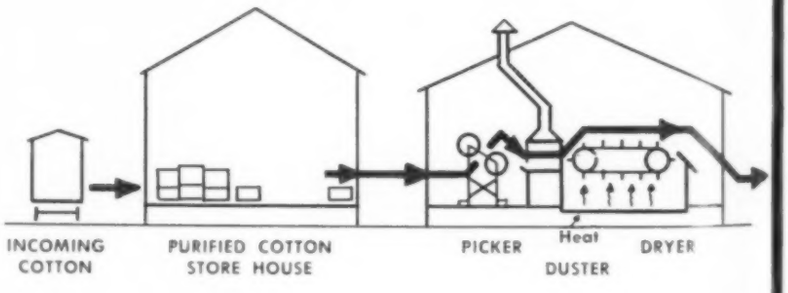
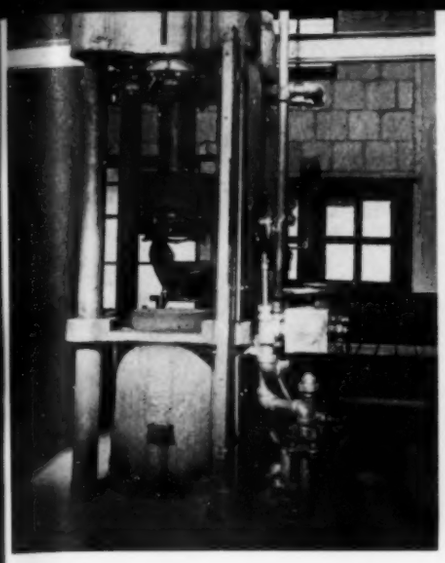


1 In the purification of the nitrated cellulose it is necessary to pass it through a series of three Jordan refiners with an alkaline slurry

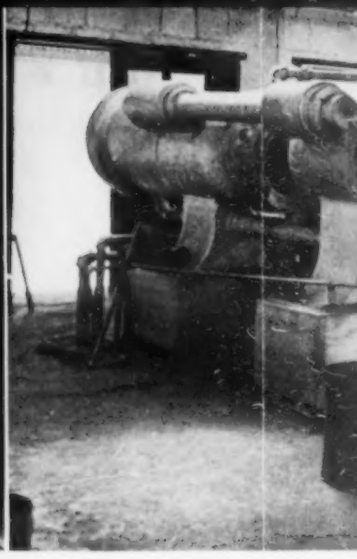


2 Final neutralization of the nitrocellulose is accomplished in the poacher house by the addition of more sodium carbonate

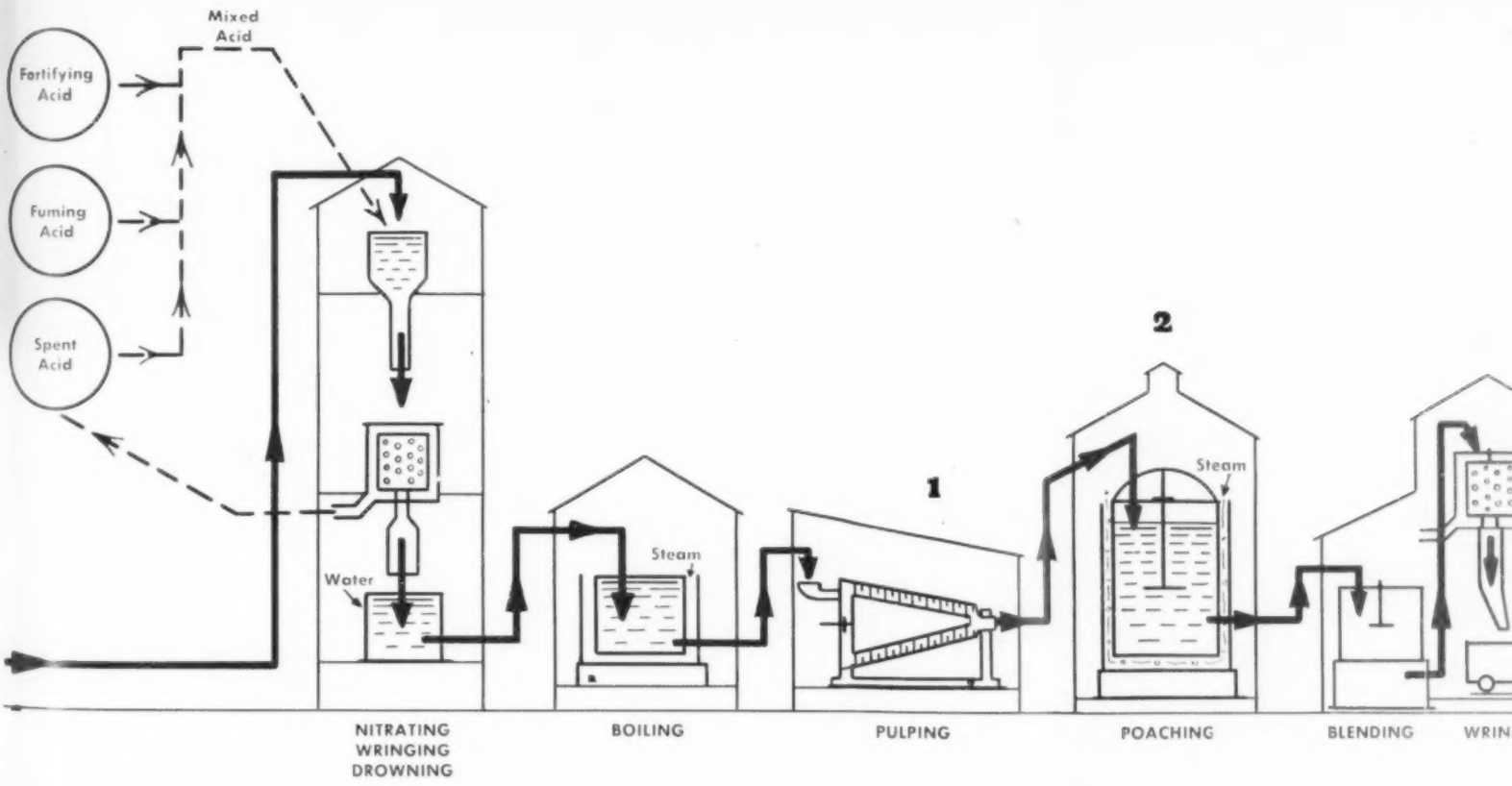


3 Alcohol is forced in at the bottom of the press displacing the water

5 The colloidal formation is completed in mixers of a slightly different type and then blocked in presses for convenience in handling

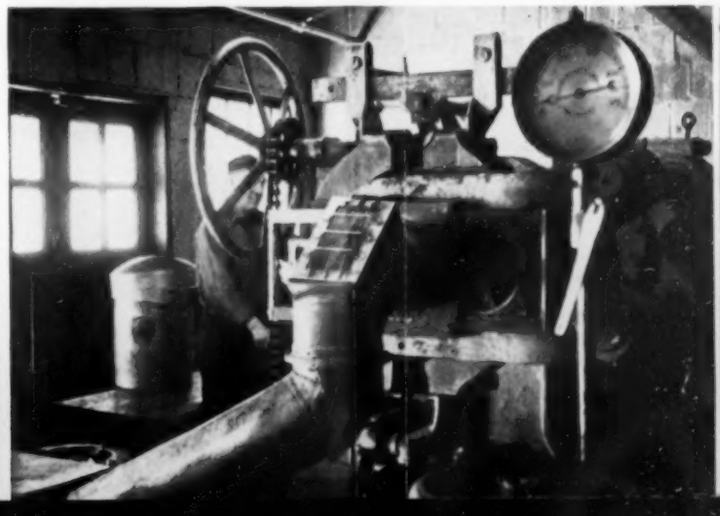


7 This powder is blocked once mo extrude the powder through screens

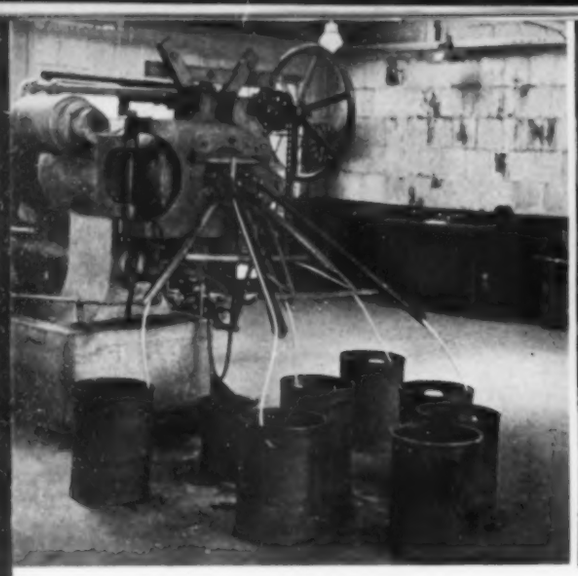


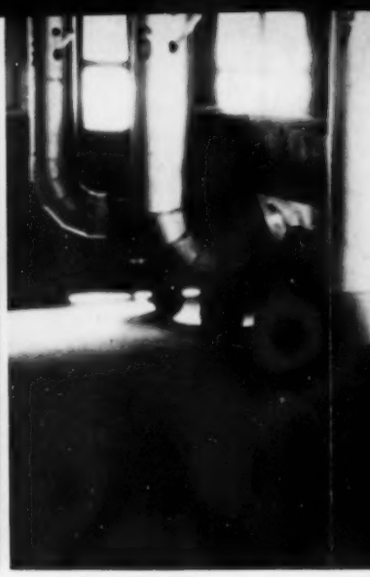
4 Actual colloidizing is done in the mixer house where the dehydrated alcohol-containing blocks are charged into mixers

6 Powder is put through macaroni press in order to remove lumps and impurities. It comes out in rope-like form



8 Strings cutter whe



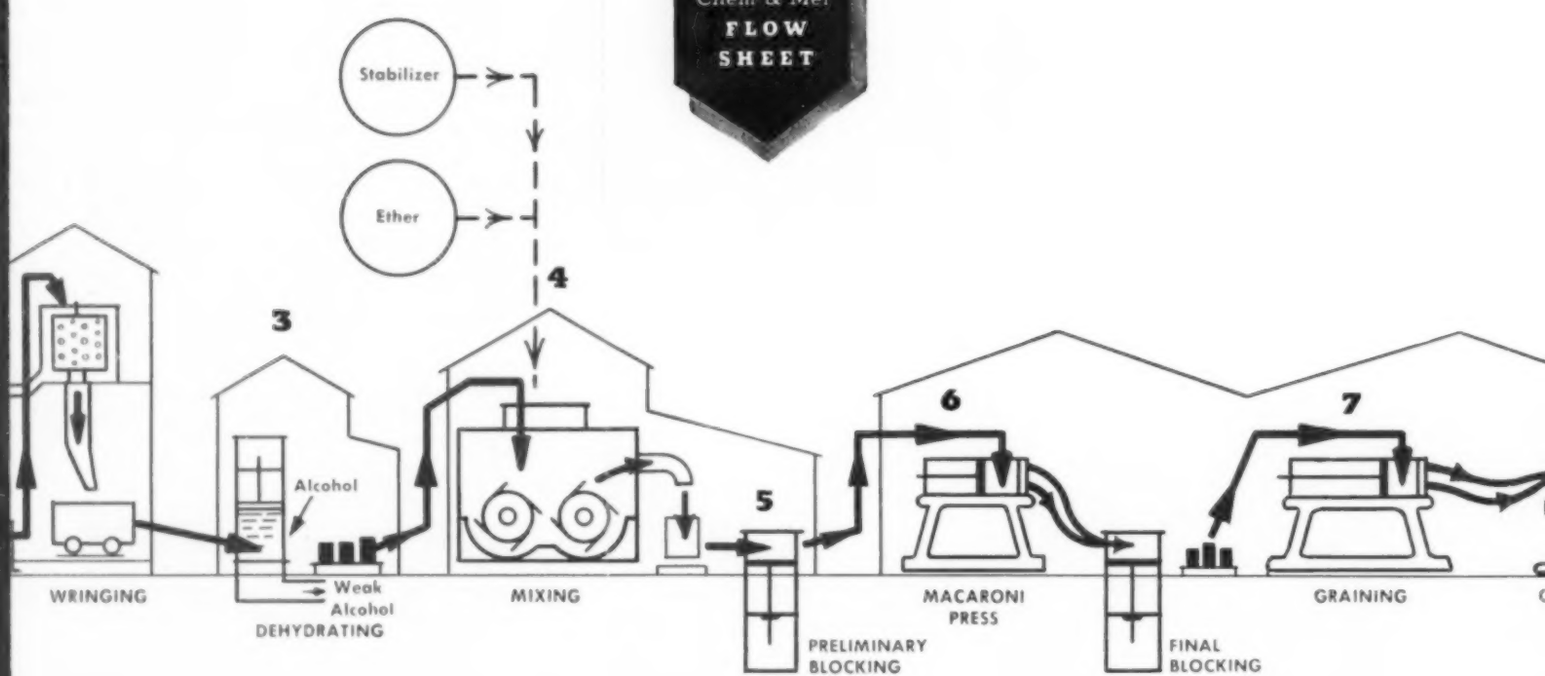


…l once more and sent to graining presses which …h screens followed by a perforated die

9 Powder is put into covered cars which are sent to the solvent recovery building

11 The mass is dumped into a bin … length of time to bring the moistu…

A *Chem & Met* FLOW SHEET

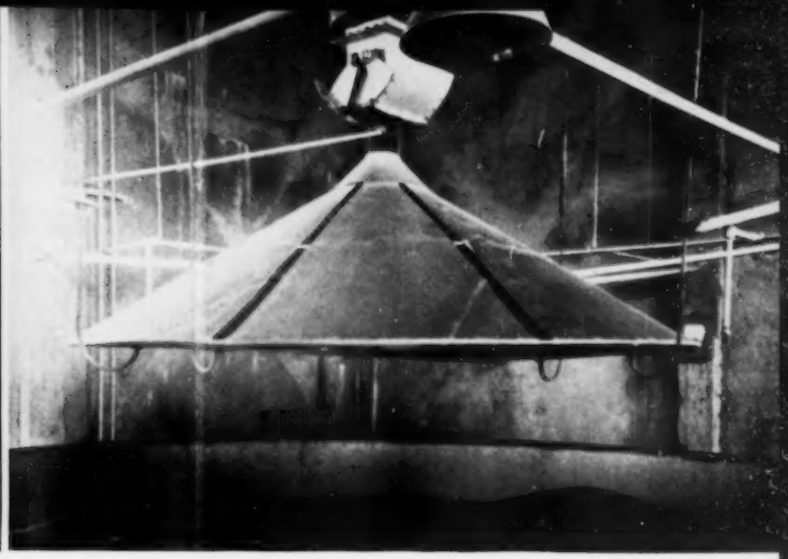


Strings of powder so obtained are sent to a …tter where powder grain lengths are regulated

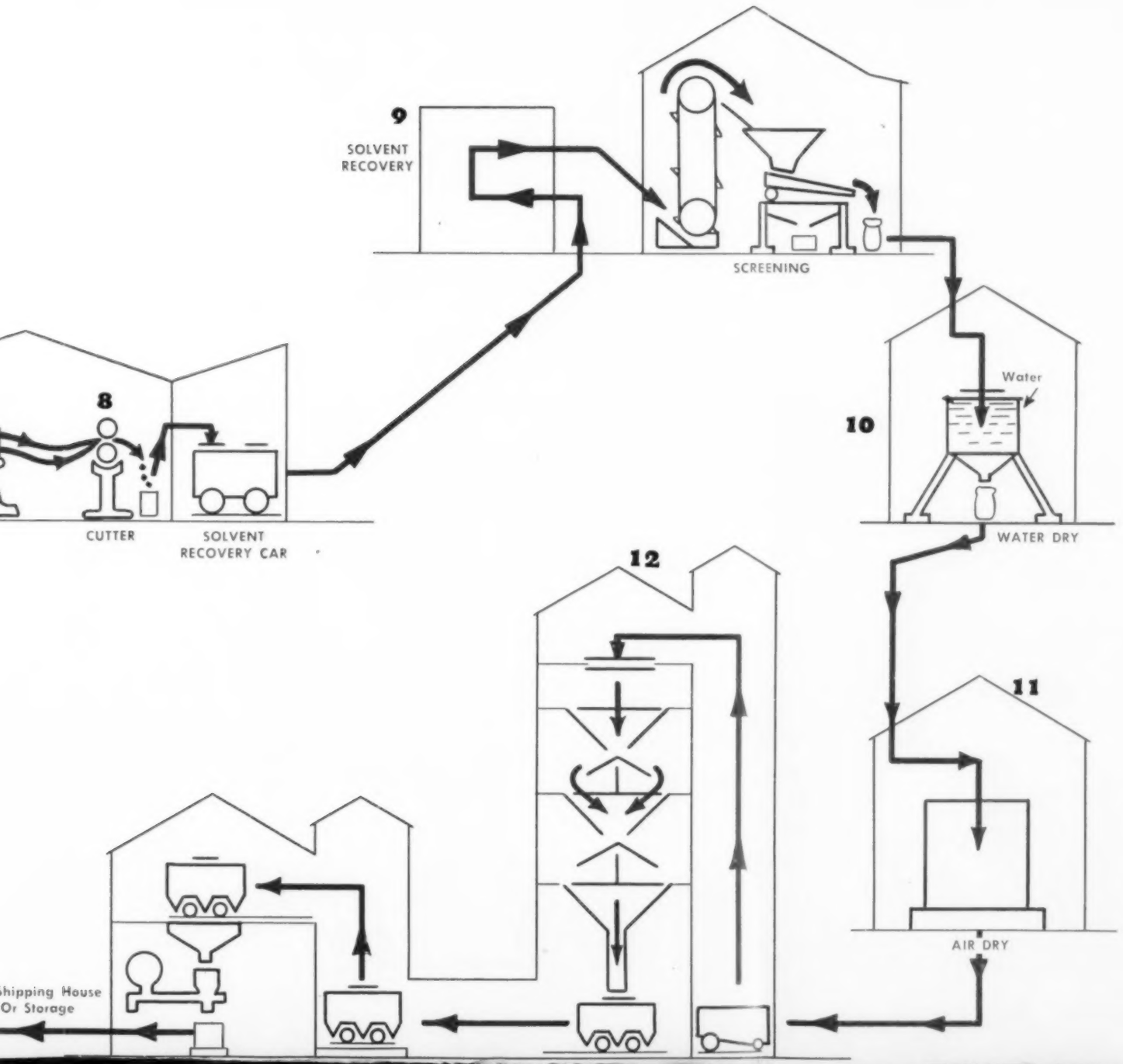
10 In the water-dry house the remaining solvent is removed. Preheated water is pumped through the tanks so that solvent may be dissolved

To Shipping Hou… Or Storage

d into a bin and hot air is passed through the powder for a sufficient
the moisture content down to an average value



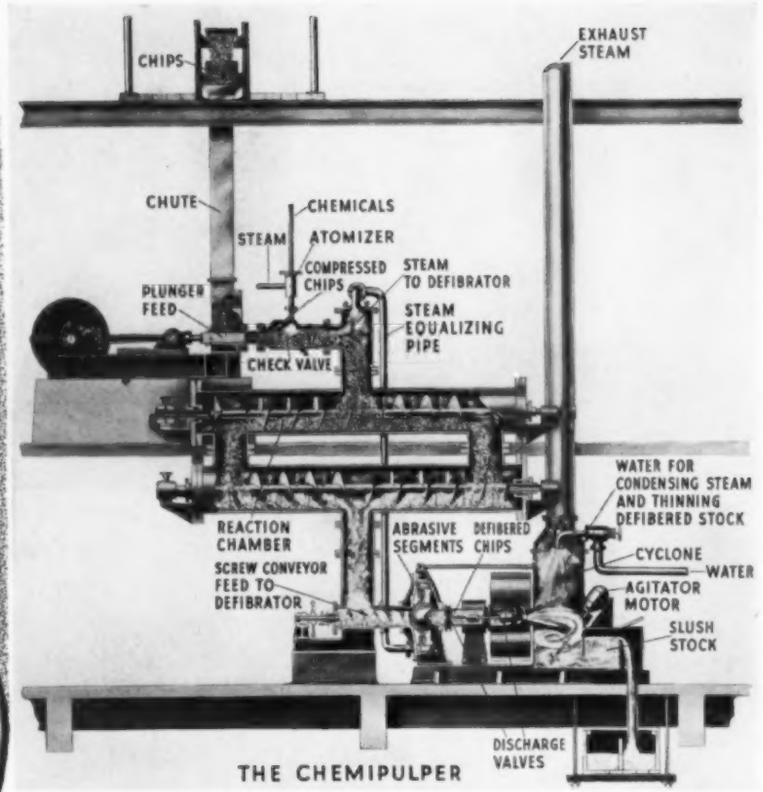
12 Blending is next in order, and blending towers with drop hoppers are provided for this purpose



THE CHEMIPULPER

PATENTS PENDING

THE CHEMIPULPER SOLVED OUR SEMI-CHEMICAL PULP PROBLEM!



THE CHEMIPULPER

Yes, the CHEMIPULPER has proved to be just the machine needed in many industries for the continuous production of free fibres for semi-chemical pulps.

Hard and soft woods, straw, bagasse, and other ligno-cellulosic materials can be converted economically into usable fibres.

Also used to produce suitable substitutes for waste paper from local deciduous, or coniferous, miscellaneous woods at a very low cost.

Ideal for the manufacture of dry felts, .009 board, and filler fibre for various grades of paper and paper boards. Also for plastics, and as a filler for many new products.

The quality and yield of fibre can be controlled to meet specific requirements. Chemical treatment can be either alkali, acid, or neutral. Low steam, power, and chemical cost.

Manufacturers — for — defense, encountering problems in producing new fibres to meet new conditions, are invited to write for further particulars.

Gentlemen:

Without obligation, please inform us how the CHEMIPULPER can be utilized to advantage for the manufacture of: .....

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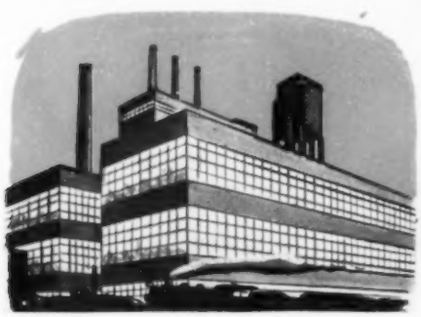
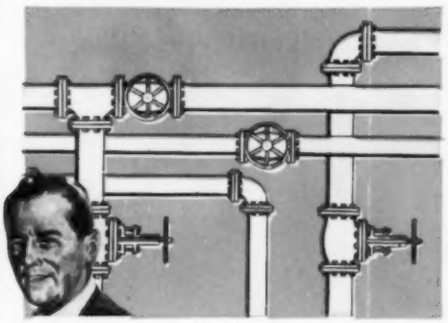
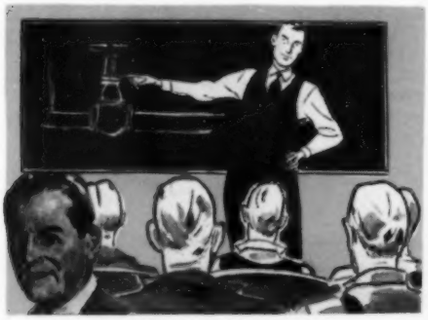


1 With the plant running 168 hours a week, we needed more and better maintenance—day and night. On piping, for example, you can't get away with part-time maintenance and keep production lines running smoothly. It's too important!

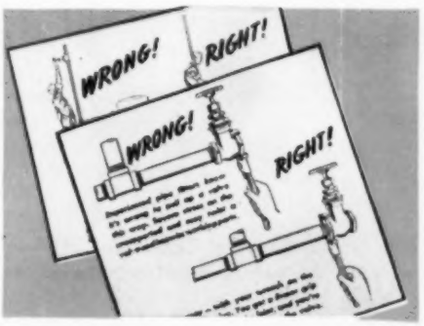


2 Soon enough, we found valves and fittings would have to be handled with unusual care to get every last bit of service out of them. They're vital equipment, and with all the demands of war, deliveries of replacements were being slowed up.

3 Sure, we put on more "maintenance" men, but many had never handled a wrench before. We had to start from scratch in training them. In the past, our veteran crews had the time to teach apprentices, but that was "before Pearl Harbor."



4 You know that piping maintenance is a specialized job. But it's knowing the "kinks" of the trade that makes the difference between good and bad installations. They help speed-up the work as well as step-up efficiency of pipe lines.



5 We had to teach these men the "rights and wrongs" of piping make-up. We had to be sure they knew enough about valves of all types, and when and where to use them. Good piping depends a lot on using the right equipment.

HOW TO KEEP YOUR PLANT GOING WITHOUT INTERRUPTION!
HELPFUL HINTS ON CHOOSING VALVES FOR BETTER PIPING SERVICE
TIPS ON VALVE TRIM

6 These Crane Shop Bulletins made a tough training job easier. They're full of valuable piping pointers. We used them in employee training classes; posted them in maintenance shops; passed them among the men. Even the old-timers use them! **And listen, any plant can get these Bulletins free—through the local Crane Representative.**

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RAYMOND IMP MILL

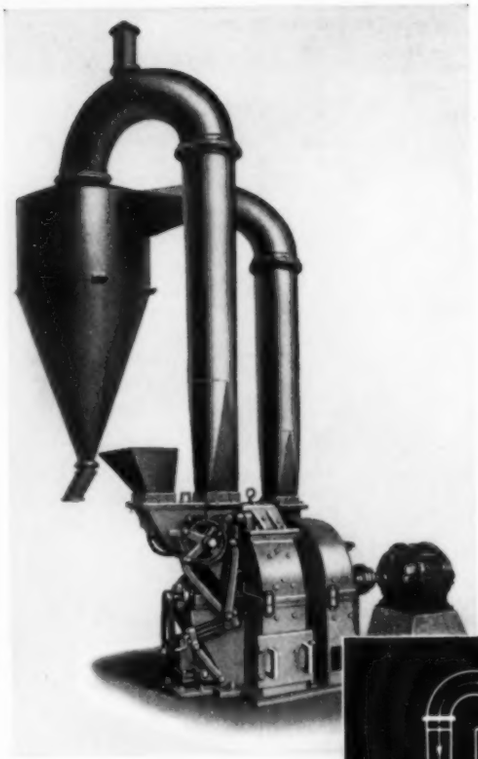
for grinding and separating
EDIBLE SOYA BEAN FLOUR
and other commercial uses

Today's great "production offensive" extends to the chemical and food industries, where Raymond pulverizing and separating equipment is providing modern methods of processing essential materials quickly and economically.

For example, in making soya bean flour both for edible and commercial purposes, the Raymond Imp Mill is recognized as standard equipment. This sturdy pulverizer is operated in combination with the Raymond Mechanical Air Separator in closed circuit arrangement.

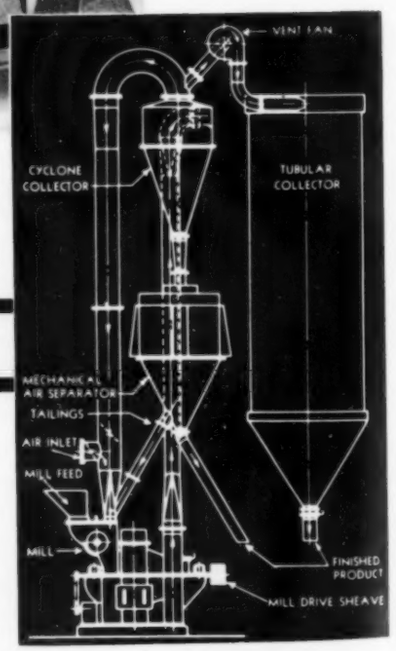
The mill reduces the soya beans to finely powdered form and discharges the product to the separator. Here the fines are taken off, delivering a uniform material at a fineness of 99% passing 150-mesh. The oversize is returned to the mill for re-grinding. Capacities up to two tons or more per hour are obtained and the operation is automatic and dustless.

This Imp-Mill-Separator system is also used for grinding starch, synthetic resins, carbon products, copper sulphate, phosphate materials, kaolin, pigments and chemicals of various kinds. The unit is built in several different sizes to suit the capacity requirements of large and small plants.



The Standard Raymond Imp Mill with cyclone collector, exhaust fan and piping for air separation system.

SINCE 1887



Typical Set-up for Soya Bean Pulverizing

For this operation, the Raymond equipment includes the Imp Mill and cyclone collector, arranged in closed circuit with a Mechanical Air Separator. A tubular collector is used in the system for recovering the extreme fines and insuring dustless operation.

In cases where the product is to be dried, as in handling such materials as steamed bone, the Imp Mill is equipped with Flash Drying. By this method, the material can be reduced and the moisture removed in one simultaneous operation.

For further details, ask for Imp Mill Catalog #41

RAYMOND PULVERIZER DIVISION
COMBUSTION ENGINEERING COMPANY, INC.
1311 North Branch Street CHICAGO
Sales Offices in Principal Cities • • • In Canada: Combustion Engineering Corporation, Ltd., Montreal

Technical, Industrial, Personal

CHEM & MET NEWS

GENERAL ANILINE'S NEW BOARD OF MANAGING DIRECTORS

Appointment by the U. S. Treasury Department of a new four-man board of managing directors for General Aniline & Film Corp. has received wide approval, both in chemical industry and in financial circles. That the affairs of this huge foreign-owned company

Robert E. McConnell

Rapport Studios

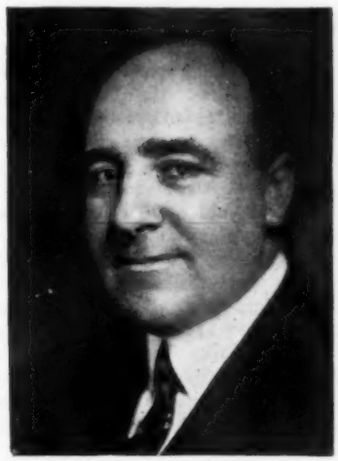
Albert E. Marshall

should now be administered by four widely known American engineers and executives is regarded as a forward step in the control of alien property. In contrast with the practices of World War I, this property is to be operated as a going concern, accountable only to its stockholders, which in this case is primarily the United States Government.

President of the corporation is Robert Earll McConnell, mining engineering graduate of Columbia University. After a number of years of experience in copper mining, he became president and director of the Mayflower Associates and the Pilgrim Exploration Co.

In the last war, Mr. McConnell was an officer in the U. S. Naval Reserve, working on the fixed nitrogen program. Recently he served as director of the Conservation Unit of OPM and as chairman of the Engineers Defense Board, made up of representatives of the principal engineering societies.

Second director and vice-president is A. E. Marshall, former consulting chemical engineer to many leading American chemical companies who has been president since 1938 of the Rumford Chemical Works of Rumford, R. I. Born in Liverpool, England, in 1883, and honor graduate in chemistry and engineering from several British universities, Mr. Marshall has spent practically all of his working life as an American citizen specializing in the acid and heavy chemical, glass, plastics and phosphate industries. He is a past-president of the American Institute of Chemical Engineers and served as chairman of



Robert E. Wilson

the American Section of the Society of Chemical Industry of Great Britain.

The third director, Robert E. Wilson, president since 1937 of the Pan American Petroleum & Transport Co., the American Oil Co. and other subsidiaries, was born in Beaver Falls, Pa. in 1893. He graduated with honors from Wooster College in 1914 and completed his post-graduate training in chemical engineering at Massachusetts Institute of Technology. He served in the first World War as a captain and later as Major of Chemical Warfare Service in charge of research on gas mask absorbents and related problems. He returned to M.I.T. as director of the Research Laboratory of Applied Chemistry, but in 1922 resigned to join the research department of the Standard Oil Co. (Ind.). When he left that company to join Pan American, he was its vice-president and director of its development and patent department. From June 1940 to August 1941, Dr. Wilson served as chief petroleum consultant to OPM and its predecessors. He is now chairman of the Committee on Petroleum Economics of the Petroleum Industry War Council and consultant to the National Defense Research Committees.

George M. Moffett, was born in Parkersburg, W. Va., and educated at Princeton. Since 1904 he has been identified with the corn products refining industry, becoming vice president of the Corn Products Refining Co. in 1916 and has been its president since 1931. He is director of the Commercial Solvents Corp., the South Puerto Rico Sugar Co. With OPM in 1940, he has succeeded to a number of important responsibilities in defense and war work including that of advising the Reconstruction Finance Corporation on many technical and industrial matters. He lives on and operates a farm in Queenstown, Md.

(Announcement of the board's appointments to vice-presidents Jos. S. Bates and Wm. F. Zimmerli is reported under "Personalities" in this issue.—Ed.)

Blackstone Studios

George M. Moffett

PINE CHEMICALS FELLOWSHIP ESTABLISHED BY HERCULES

Hercules Powder Co. has established a fellowship, to be known as the Pine Chemicals Fellowship, at Mellon Institute of Industrial Research at the University of Pittsburgh for the year 1942. Dr. George B. Field of the Institute will be the fellow.

The purpose of the fellowship will be to develop new uses for rosins, and will emphasize applications of these materials in the war effort. The fellowship continues the company's policy of expanding the uses of naval stores products, turpentine, pine oil, and rosin.

News from Washington

WASHINGTON NEWS BUREAU, McGRAW-HILL PUBLISHING CO.

RUBBER production by process industry has become one of the most urgent and also most controversial of Washington problems. The favorite political technic of mud slinging has obscured much of the factual detail. In fact, emotional rather than engineering procedures have prevailed during most of March. Despite this, some real progress in contracts for rubber-making chemicals and rubber synthesis has been achieved by W.P.B.

Most spotlighted was the controversy over the patents formerly owned jointly by Standard Oil and I. G. Little emphasized are two major reasons why these patents were handled as they were. First is the fact that a bona fide exchange of technical information across international boundaries had been going on for many years. And this had been bringing to the United States the German "know-how" as well as the German patents. Naturally, in return comparable information had been given to the Germans, all with the full knowledge of government officials. Second is the fact that no rubber companies dared begin extensive synthetic rubber development lest they jeopardize their opportunity to get natural rubber from the cartel whose methods were beyond the reach of United States anti-trust laws. This dominant factor has not been used as a defense by either rubber companies or Standard Oil officials as it might have been.

Rubber Prospects

The serious and continuing shortage of rubber has been repeatedly spotlighted by official statement during March. There is no doubt that even Congress now accepts the idea that civilians will have to get along without tires for some years. The best evidence of the acceptance of this forecast is the formal request from one of the Congressional committees that the Bureau of Standards look into claims that retreading of tires with scrap rubber is possible. This "grasping at a straw" shows that even unpromising prospects will be pursued to the limit of their possibility.

Much more attractive, though not the real solution, are the current efforts to develop guayule, to bring rubber out of the Amazon Valley, to rush rubber from Ceylon lest it fall, and other projects. Every one of these is getting support of every division of government that can help. In fact, sometimes the effort to help is resulting in a bit of confusion as to who is boss and who is responsible for particular moves.

Formal announcement has been made on several occasions that 600,000 tons of synthetic rubber capacity would be built as promptly as possible. R.F.C. financing is promised. Formal contracts are being negotiated by Defense Plant Corp. with the active participation of W.P.B. chemical executives. The only difference of opinion relates to the speed at which these plants can be put into operation.

There is no doubt that the fullest possible industrial collaboration will be afforded. Chemical, rubber, and petroleum enterprises are all actively participating in plans. A patent pool has been established which permits any company to get not only patent licenses but assistance on the know-how. Exclusive features and competitive effort have been laid aside so that no technicalities remain in the way. The problem is now to get the necessary materials of construction and speed the engineering job at the maximum rate.

Sugar vs. Corn

Only a little less controversial than the rubber projects have been the arguments in Washington as to the source of industrial alcohol, of which huge quantities are needed for the war effort. Everyone from the over-zealous advocate of chemurgy to conservative engineers knows that the maximum amount of alcohol should be made from cereal grains in order that the minimum drain on the sugar supply will be imposed by our alcohol manufacturing job. The important question has been, therefore, as to the practicable means for procedure.

Definite steps have been taken to put the maximum amount of industrial alcohol manufacture on a corn base. But there is serious objection to extensive plant additions for this purpose because of the shortage of machinery and materials of construction. Preparation of substitutes for molasses in existing plants has, therefore, been taken. Several important proposals of this sort are being pressed and probably will result in extension of molasses supply without using much raw sugar. The first step in this direction was taken during March, permitting the release of over a half million tons of raw sugar to the refiners which previously had been held, in fear that it might be needed at alcohol plants.

The propagandists for small alcohol units in farm areas have had a field day with mid-Western Congressmen shouting them on. (This is an election year.) But shortage of equipment and steel for construction is likely to prevent any substantial development of such new plants as would otherwise have enthusiastic Congressional support. So long as corn or wheat can be put into fermentable form without new machinery, that route is going to be chosen.

All the beverage industries are now actively cooperating. Unexpectedly large gallonage of high-proof alcohol is being furnished. Still further production at moderate proof will be forthcoming shortly. Thus, makeshift chemical engineering is doing an exceedingly satisfactory job for W.P.B. Chemical Branch. Naturally, too close scrutiny of costs is not being allowed to hold up this progress. Furthermore, most of the establishments going ahead on these novel programs will certainly wish to return to their old business at the end of the war.

Vegetable Oils Restricted

Shortage of vegetable oils for various process industries was met by several official orders issued late in March. Two outstanding preference orders indicate the policy that is going to prevail governing industrial use of vegetable oils for the emergency.

Coconut oil and related oils high in lauric acid values have been restricted in use several ways. Any user must recover 90 percent of the theoretical glycerine. He must not allow more than 1.5 percent glycerine in any industrial product made. Use is forbidden for margarine, shortening, or cooking fats. For most other purposes not more than 75 percent of the average rate of usage in 1941 is permitted from this time on.

A comparable order M-59 for palm oil restricts its use to tin-plate making or to soap, with the requirement of 1.5 maximum glycerine content. Twenty percent of the available stocks of this oil are ear marked for subsequent government allocation. The comparable restriction on coconut and related oils was 25 percent for the reserve in the case of any company having as much as 30,000 pounds or more in storage, either as fat or in products.

Evidence continues to accumulate that a serious general fat and oil shortage is threatened next year. Thus, the pressure of the Department of Agriculture is intensified to secure maximum oil seed crops this season. Rationing of food fats next year is not beyond the range of possibility if serious drought or other difficulty prevents reaching crop goals that have been set.

Explosives Or Fertilizer

Plans for increased ammonia production have reached substantial totals. The limiting factor on this development is still, as formerly, the ability to get special high pressure chemical engineering equipment more rapidly. Were it not for that factor, present plants would be further expanded and several new ones added to the program.

Ammonia supply for this year comfortably approaches what might be called "adequate." But already there is evidence that for 1943 there will be severe competition between the fertilizer industry and the explosives maker for the less-than-desired total of ammonia supply. Agriculture officials recognize that war demands must take precedence in many respects. But they point out that Uncle Sam not only must feed his own population, but also many millions of allied peoples. Agricultural goals cannot be reached next year without a generous supply of fertilizer. That means more ammonia

for fertilizer than is now readily available.

This situation has not yet become acute, and some way may be found to stretch the supplies. Plans are already being made to increase legume crop usage. Any industrial wastes containing usable nitrogen are to be diverted to fertilizer, if more important usage is not possible. But the very great demand for protein feeds continues to threaten any large use of protein wastes as fertilizer. Any industrial unit which can offer even small help in offsetting the prospective shortages will be cordially welcomed, both at W.P.B. and at the Department of Agriculture.

Economic Warfare Troubles

Certain technical difficulties underlie the current situation at the Board of Economic Warfare. That agency is dealing with complicated technical questions not only in the field of export control, but also in those involved in supply of materiel and other necessary Lend-Lease goods.

The spotlight was turned on this agency by Representative Dies' criticism of nudists and other ism advocates. This attack, rather ably refuted by Vice-President Wallace, has resulted in quiet but nonetheless searching comment of another sort. This relates to the question as to whether adequate engineering and scientific review is being given to some of the findings of this Board.

Critics, including those of the most friendly disposition, point out the decisions at the Board of Economic Warfare are intrinsically technical. They have to do with goods plans and goods allocations. It is not enough to consider these from the standpoint of the economist conversant with international trade and exchange. All of the normal rules which govern that type of professional review are now either forgotten or suspended. In other words, we are working under a "goods economy" rather than a "money economy."

It is becoming generally recognized in Washington that many of the wartime problems involve this particular complication of adjusting the thinking of economists to the realistic goods situation. Some conscious effort is being made to accomplish this adjustment, partly by putting technical men in charge, at least so far as review of policy decisions is concerned. Chemical-engineer executives will contribute to the speed-up of this movement if they will emphasize the need on any appropriate occasion.

Chemical Miscellany

Anti-Trust Policy—The President has discovered that his zealous aide, Assistant Attorney General Thurman Arnold, is interfering with certain war programs. This accounts for the promise that further prosecutions under anti-trust laws may be delayed where War or Navy officials request. Meantime several anti-trust decisions not too favorable to Mr. Arnold's cause have been announced. Among others is the group of nominal fines imposed on fertilizer industry executives and companies following a nolo contendere plea at Winston Salem. The aggregate fine imposed on 102 defendants initially indicted is $255,000. The practices of National Fertilizer Association were, in effect, fully justified in the complimentary dismissal of the charge against Executive Secretary Charles J. Brand. Not even a nominal fine was imposed on him, as the judge indicated that he found clear evidence of full intent to meet both letter and spirit of the law.

Idle Equipment—W.P.B. officials are struggling valiantly to find any idle chemical engineering equipment. Uncle Sam now has authority to seize this and put it to work where voluntary arrangements cannot be made quickly enough to satisfy urgent needs. Where makeshift adaptation of old equipment is possible, this is urged even when substantial increase in cost results. Speed in production takes precedence over everything else in such cases.

Manganese Plans—Very great extension of the domestic manganese program was arranged during March. W.P.B. has announced contracts for 10 new plants. Three of these to produce about 400,000 tons of manganese concentrate will use chemical engineering methods for leaching manganese from low-grade ores and production of nodulized concentrate suitable for ferro silicon making. Other smaller plants will provide for beneficiation by customary ore dressing methods.

Bag Shortage—Any kind of packaging material is scarce. This has compelled aggressive action by W.P.B. to get enough paper bags, cotton bags, and other containers for chemicals and agricultural materials. Any use of burlap is, of course, "out." Re-use of second-hand containers is urged wherever possible.

New Magnesium Minerals—The government is receiving encouraging reports regarding newly identified sources of olivine and new high-strength magnesium brines. The maximum speed-up of production from these sources will supplement sea water and dolomite which prospectively will furnish the bulk of the raw material for the many new magnesium plants now under way.

Strategic Research—Additional appropriations of more than $2 million have been recommended by the President for the U. S. Bureau of Mines' strategics research. That Bureau is speeding up its programs for all types of mineral recovery. Most of the projected research is being done under the advisory direction of the special committee of industrial experts which serve both the Bureau and W.P.B.

Censorship Rules—The War Department now forbids the giving out of information by its own field force or contractors dealing with new plant construction. Companies engaged on military projects are required to withhold many details formerly freely published. Comments on exact site, process, capacity, date of operation, progress of work, or production schedules is specifically forbidden.

Laboratory Licenses—Both Control laboratories and research groups require a license if they make, have, or use any of the named "ingredients" subject to regulation under the Federal Explosives Act. Careful record must be kept of receipt and disposition of all goods. Any losses must be reported for F.B.I. or Bureau of Mines investigation. The government holds any licensee responsible for great care in preventing diversion of such materials.

Negotiated Contracts—On March 4, W.P.B. Chairman Nelson ordered that further war contracts on all military supplies be negotiated rather than placed by competitive bids. Preference is to be given to bidders who offer the maximum speed of delivery rather than those offering the lowest price. Small firms able to make satisfactory deliveries of simple standard materials are to get preference so that facilities of big concerns can be reserved for more complicated and difficult items. Subject to these restrictions, preference is always to be given to a concern which can make the desired delivery with a minimum requirement of new machinery or equipment.

More Controls—Shortage of many more industrial chemicals and products of process industry intensifies the effort to maintain an orderly flow under government supervision. Relatively few new price ceilings have been required. But many more allocation plans are being set up. It will not be long before all distribution of scarce commodities will have to be in accordance with detailed preference orders from W.P.B.

The Glycerine Tail—Some folks think that the glycerine tail is wagging the soap dog. The urgency of need for glycerine is not questioned by these critics. But they do point out, rather convincingly, that there will be a shortage of food fats next year unless agricultural goals of exceptionally high level are met. Then the question will be whether retention of fat and food usage is not more important than getting glycerine via the soap kettle.

MATHIESON WILL OPERATE NEW SYNTHETIC AMMONIA PLANT

Immediate erection of a plant to produce ammonia and derivatives was announced early in April by E. M Allen, president of Mathieson Alkali Works, Inc. The plant will be financed by the Defense Plant Corp., and will be built and operated by the Mathieson organization. The ammonia will be produced synthetically through use of a modification of existing methods.

COMPANIES PARTICIPATING IN SYNTHETIC RUBBER PROGRAM

Official announcement of the companies to participate in the government's synthetic rubber plant construction program was made at the beginning of April by Federal Loan Administrator Jesse Jones. A total of 25 large concerns and several groups of smaller ones will share in what Mr. Jones expects by the end of 1943 to be a program on a 700,000-ton-a-year basis.

Neither individual company allocations nor plant sites will be officially disclosed in an overall picture, but it is known that the program involves production on a mass scale of both buna and butyl rubber, using alcohol and petroleum in various forms as the butadiene base. In other words, every process which has had pilot plant testing will be used, a factor which may ultimately reduce the amount of synthetic actually obtained from the 700,000 tons of plant.

It is admitted, furthermore, that the goal of 700,000 tons of capacity by the end of 1943 is dependent upon fully adequate priorities for equipment, a decision which is exclusively up to the War Production Board which will reserve the right to stop short of Jones' goal at any time it feels the material can better be utilized elsewhere. Civilians, in other words, should not be misled into feeling that because the Jones program equals in potential capacity normal American consumption of crude they will be getting tires and the like in 1944. If plants are constructed up to 700,000 tons of capacity it will be because that much is needed to fill the military requirements of the United Nations.

The companies Mr. Jones announced as participants in the synthetic program are: Atlantic Refining Co., Carbide & Carbon Chemicals Co., Celanese Corporation of America, Cities Service Oil Co., Dow Chemical Co., E. I. du Pont, Firestone Tire & Rubber, B. F. Goodrich Co., Goodyear Tire & Rubber Co., Gulf Oil Co., Humble Oil Refining Co., Hycar Chemicals Co., Koppers Co., Monsanto Chemical Co., Phillips Petroleum Co., Pure Oil Co., Richfield Oil Corp., Shell-Union Oil Corp., Sinclair Refining Co., Socony-Vacuum Oil Co., Inc., Standard Oil of Ind., Standard Oil of N. J., Standard Oil of La., Texas Co., United States Rubber Co.

ANALYSIS OF BASIC PRIORITY ORDER FOR CHEMICAL TRADE

An exhaustive analysis of the "do's" and "dont's" of the chemical industry's basic operations priority order, P-89, has been prepared by the War Production Board Chemical Branch under the direction of Dr. David L. Watson, administrator of the order, and Dr. Ernest W. Reid, chief of the branch.

Basic purpose of the order is to facilitate acquisition of operating supplies and maintenance repair materials to keep qualified chemical plants at their current level of operation. The plan is not available to all chemical plants and the branch says they will be "carefully restricted to manufacturers of kinds of chemicals essential to the war program, national welfare, or government-sponsored enterprises, or to those, the nature of whose business is such that its continuous operation is definitely essential to war production."

Operations consisting solely of mixing, pulverizing, fabricating or processing in which there occurs no easily recognized chemical reaction are not eligible for P-89. Only operations involving a bona-fide chemical change as an essential aspect of the operations are qualified under the definitions to obtain the necessary serial number by applying on Form PD-315.

ARMOUR TO MAKE INDUSTRIAL SURVEY OF ARGENTINA

The Armour Research Foundation has been commissioned by the Argentine Trade Promotion Corp. to make an industrial survey of Argentina and its raw materials and products. The Foundation, which is affiliated with the Illinois Institute of Technology in Chicago, will send a field party to Argentina to make the survey. The Armour representatives will spend from six months to one year there. Main purpose will be to study raw materials in Argentina with a view towards their immediate possibilities for development for export and for their use in domestic industrialization. The results are expected to aid in the export-import relations of Argentina, the improvement of which is the ultimate aim of the study.

HANSGIRG PLACED IN ALIEN CONCENTRATION CAMP

Dr. Fritz J. Hansgirg, Austrian-born scientist, who has been consulting engineer at the magnesium plant completed last year at Permanente, Calif. for the Permanente Corp. was taken, on April 3, to an alien concentration camp. Dr. Hansgirg was taken into custody last December by the Federal Bureau of Investigation and confined to the Santa Clara County jail. It has been reported that while detained in the jail, Dr. Hansgirg directed the engineering activities at the plant through contact with the operating engineers. No reason has been given for his removal to the concentration camp.

Factory Consumption of Primary Animal and Vegetable Fats and Oils, by Classes of Products, Calendar Year 1941

(Quantities in thousands of pounds)

Kind of Fat or Oil	Total	Shortening	Oleomargarine	Other Edible Products	Soap	Paint and Varnish	Linoleum and Oilcloth	Printing Inks	Miscellaneous Products	Loss (including oil in foots)
Total	5,860,742	1,418,109	294,912	534,637	2,143,857	570,802	136,840	29,319	543,615	188,651
Cottonseed oil	1,443,602	888,733	149,991	311,569	3,010	196	.....	153	4,106	85,844
Peanut oil	114,300	81,905	2,209	18,102	597	.....	.....	.....	5,112	6,375
Coconut oil	637,970	22,069	29,786	54,156	484,124	919	.....	1	8,639	38,276
Corn oil	84,342	62	628	62,963	4,948	848	1	34	2,776	12,082
Soybean oil	463,686	215,967	75,634	47,976	24,737	41,594	7,666	255	23,445	26,412
Olive oil, edible	2,484	.....	.....	2,308	84	.....	.....	.....	92	.....
Olive oil, inedible	2,697	.....	.....	.....	555	4	.....	.....	2,138	.....
Sulphur oil or olive foots	10,618	.....	.....	.....	10,029	.....	.....	.....	589	.....
Palm-kernel oil	10,364	4	957	6,916	1,113	.....	.....	.....	70	1,304
Palm oil	278,487	86,486	4,991	1,670	129,871	.....	.....	1	*43,768	11,700
Babassu oil	38,977	.....	946	6,677	29,753	.....	.....	.....	54	1,547
Sesame oil	887	226	.....	293	304	.....	.....	.....	45	19
Rapeseed oil	12,054	.....	.....	.....	5	103	.....	.....	11,928	18
Linseed oil	539,362	.....	.....	.....	2,278	373,745	110,236	23,547	28,423	1,133
Tung oil	54,008	.....	.....	.....	.....	48,825	1,896	2,960	327	.....
Perilla oil	7,024	.....	.....	.....	.....	5,408	340	831	445	.....
Castor oil	89,920	.....	.....	.....	1,976	44,240	1,295	760	41,643	6
Other vegetable oils	23,723	93	.....	3,524	1,162	13,690	723	80	3,912	530
Rendered pork fat	49,641	45,550	.....	3,979	1	.....	.....	.....	.....	111
Lard	18,606	5,237	8,298	4,724	88	.....	.....	13	37	209
Edible animal stearin	31,473	23,103	3,057	4,817	70	.....	.....	.....	391	35
Oleo oil	20,408	1,282	18,415	77	189	.....	.....	.....	433	12
Tallow, edible	53,001	41,227	.....	4,886	4,826	.....	.....	4	1,936	122
Tallow, inedible	1,190,542	.....	.....	.....	1,057,303	364	1	10	131,364	1,500
Grease	470,214	.....	.....	.....	310,487	150	.....	472	157,991	1,114
Neat's foot oil	7,224	.....	.....	.....	35	37	.....	.....	7,139	13
Marine mammal oils	18,097	.....	.....	.....	6,889	26	.....	10	11,172	.....
Fish oils	187,031	6,165	.....	.....	69,423	40,653	14,682	179	55,640	289

* Includes 42,059 thousand lb. consumed by the tin and terne plate industry.

A WORLD OF EXPERIENCE IN STAINLESS STEEL

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RESTRICTED SHIPPING SPACE BROADENS IMPORT AND EXPORT CONTROLS IN GREAT BRITAIN

Special Correspondence

RECENT British control orders clearly reflect the increased need for economy in the use of shipping space and raw materials in the light of Far Eastern developments. Import licenses are now required for purchases of shellac from Empire sources and the export license system has been extended to chlorinated rubber and diphenyls; casein glue; glue, gelatine and size derived from animal sources; vegetable adhesives; asbestine; feldspar and talc; barytes and witherite, barium carbonate and sulphate (including blanc fixe); inorganic fluorine compounds; and a number of other products of less immediate concern to the chemical industries.

Shortage of raw materials or foreknowledge of further tightening of supplies has given a strong impetus to a variety of new productions. Salvage of formerly wasted byproducts and reclamation of waste products are now the object of government propaganda and support. Reasons of space make it impossible to give more than a few examples of waste recovery and substitution typical for this trend in British chemical production today.

Several new refineries for the treatment of reclaimed lubricating oils are now in course of construction, and a growing number of consumers of lubes filter their used oil for further consumption. The salvage of lubricating oils, not only for reclamation as a lubricant but for use as a fuel, has been organized on a country-wide scale by the Petroleum Department.

Rubber reclamation has been the subject of a fierce controversy in the press, but if all possibilities are utilized with resolution, work in plants operating now will undergo a 25 percent increase immediately, and a rise in capacity by 50 percent will make further expansion of production possible. Unfortunately some stocks of old rubber tires were destroyed or removed because of the fire risk in case of air raids.

The Salvage and Recovery Board has asked users of cellulose solvents not to discard them after use, but to pass them on to firms who can treat them for further consumption. Arrangements with this end in view have been made. The Board also has recommended that all industrial firms appoint a full-time or part-time salvage officer whose job it will be to find and eliminate sources of waste in his plant.

Wool grease which before the war was disposed of down the sewers of wool-disinfecting stations in Yorkshire has found useful application in camouflaging the commodity stores which have been built for the Ministry of Food at various points up and down the country. The paint is a special economy mixture said to be probably the cheapest paint used in the British Isles since the ancient Britons painted themselves with woad. Wool grease is used also for other paints, and some paint technicians foresee for it a brilliant future in the trade after the war.

The anticipated disruption of arrivals of teak wood from Burma and the growing scarcity of such wood as Douglas fir from the United States and British Columbia and kauri pine from New Zealand has aroused interest in English woods among vat makers. English oak is praised by some as an excellent material for wooden vats, even for use with acids, and English larch is also being tried out. Besides, Russian red deal is now being imported again and may help to overcome the threatening shortage.

Rubber manufacturers, faced with a reduced supply of their raw material, also look for new sources of chemical supplies. Silica flour is going to replace barytes, although Great Britain has a large production of these, if not comparable in shade with the imported Continental material. Naphthalene black, though none too plentiful, has found attention as a substitute for carbon black. Asbestine and talc, normally imported from North America and France respectively, have been replaced successfully by prepared China-clay of which large and high-grade deposits are available in the British Isles.

Imported asbestos is replaced by the British asbestos firms of Newall and Turner by various domestic materials. An activated chalk is made for use as a reinforcing agent in rubber materials. For refrigeration insulation a new product is made from English peat; its thermal efficiency is claimed to be fully equal to corkboard while its weight is lighter. Besides, Turner Bros. Asbestos Ltd., another subsidiary of the group, has built a new factory for asbestos cement roofing materials.

To the group of substitutes belongs also common salt, now recommended by the Ministry of Agriculture as a fertilizer material which has been found especially helpful where potash supplies are limited or farmyard manure scarce. When crop yields are forced up by liberal applications of sulphate of ammonia, salt acts very well, especially on mangolds and sugar beet. Barley is also likely to profit from the use of agricultural salt. It also increases the straw of oats and beans considerably, but it was found to be definitely harmful to a few other crops, notably potatoes, and if it is used in heavy dressings, it may damage the soil texture and impair the growth of seedlings.

In Eire, where supply problems are in principle the same, the need for fertilizer supplies has caused the Government to work the rock phosphate mines of Kilfenora and Naughaville in North Clare. These mines have been worked on a limited scale, but will now be operated in a far more extensive way.

Accumulation of large quantities of creosote and pitch in various parts of England has caused many fuel consumers to change over to this new fuel compound, apparently with good results. The Government has not told firms who are making corresponding changes to do so quickly, as in future a conversion of fuel plant to the use of the creosote-pitch mixture will only be possible on the advice of the Petroleum Department.

This short list of substitutions must suffice to show the trend in the British chemical industry, but the list could be easily extended, and often it is not possible to distinguish between substitution as a wartime measure and a genuine extension of production. The British plastics industry, for instance, has brought out several new products for which there is a keen demand now because of difficulty of imports, but these articles will be retained on the production program after the war. Certain of the newer thermoplastic resins (of which the output is still forging ahead) like polystyrene, polyvinyl chloride and poly-ethylene belong to this group.

Some surprise has been caused by the British Government's decision not to build up a synthetic rubber industry. The argument that the United States with its huge petroleum industry is far better placed for the manufacture of synthetic rubber is certainly deserving consideration, but there are big refineries in the British Isles, acetylene is now also made here, and other materials for the manufacture of synthetic rubber can be obtained from coal derivatives, hydrogenation and coke-oven gases. At present, however, difficulty in the provision of plant and equipment seems to be the main obstacles.

The rationing of soap to 3-4 oz. per person a week is expected to result in a reduction of British soap consumption by one-fifth. Toilet soap, household soap and soak flakes are subject to rationing, but shaving soap, liquid soap and shampoo soap have been left outside, and allocations to manufacturers will also be arranged without any further cut on the basis of consumption during the last six months. As hitherto, rather more than 300,000 tons of oils and fats were consumed by the British soap industry every year, the saving in shipping resulting from soap rationing will be considerable, but it is not anticipated that the demand for chemicals in the soap industry will decline by a similar margin. In the first place, chemicals enter soap for industrial purposes in larger quantities than toilet or household soap; secondly, efforts will be made to raise the percentage of chemical constituents at the cost of fats and oils; thirdly, it is anticipated that more soda crystals and other water-softeners will be bought

3 PORTER ANSWERS...

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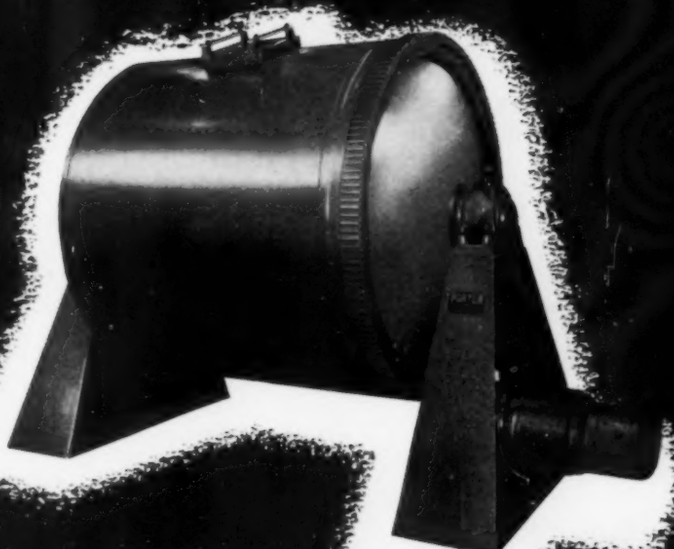

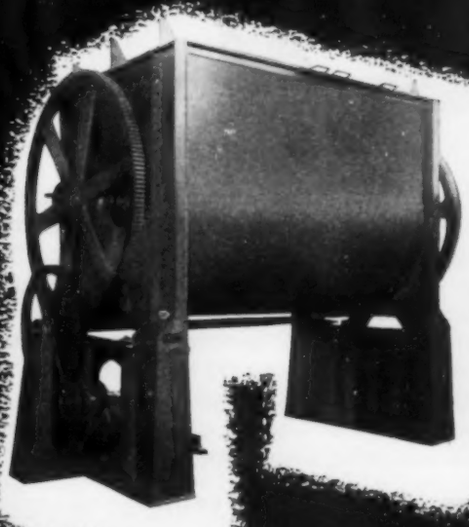

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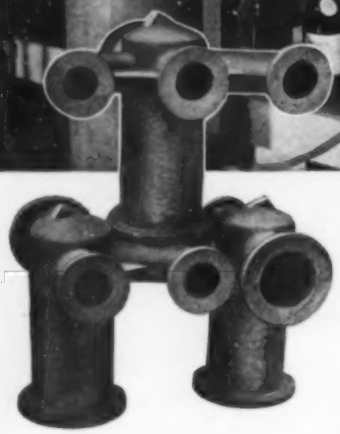

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by manufacturers who have to curtail their consumption of soap.

The vitamin industry finds it rather difficult to cope with the increasing demand for its products. British production now includes ascorbic acid, aneurin, nicotinic acid, tocopherol, calciferol, and a concentrated vitamin A product, but the total output is, of course, very small. Vitamin D (calciferol) is now being made by four firms, although the total amount required for the fortification of margarine in the United Kingdom does not exceed one pound per month. Owing to the growing demand for vitamins as food enrichers restrictions have had to be imposed on their use, but vitamins B_1 and D are still available for pharmaceutical purposes. Vitamin C may be used for tablets and other "straight" preparations, but there is a voluntary restriction whereby pharmaceutical manufacturers of proprietary brands of multi-vitamin preparations are allowed supplies of ascorbic acid on the basis of their average consumption in the five months before the Vitamin C Control Order was introduced at the beginning of June, 1941.

The rayon industry has to fill an important position in the wartime organization of British industry, but strict government control on the lines introduced in other textile trades has been avoided by voluntary arrangements. Under these the rayon producers have agreed to deliver supplies of continuous filament rayon yarn and rayon staple fiber in accordance with allocations approved by the Government. A Rayon Allocation Office has been set up to arrange for the distribution of supplies. A consultative body called the Rayon Council has been formed under the chairmanship of Sir Percy Ashley, who was until recently Cotton Controller, to coordinate the rayon industry.

CHEMICAL CONFERENCE PLANNED FOR CHICAGO CHEMICAL SHOW

Plans are rapidly shaping up for the Second National Chemical Exposition which will be held Nov. 17-22 at the Stevens Hotel, Chicago. The exposition is sponsored by the Chicago Section of the American Chemical Society with Victor Conquest, director of research for Armour & Co. as chairman of the show committee. Serving with Mr. Conquest are W. M. Hinman, superintendent of the sensitizing department of Frederick Post Co., L. E. May, superintendent of chemical products, Sherwin-Williams Co., R. C. Newton, vice-president, Swift & Co., W. C. Johnson, associate professor of chemistry, University of Chicago, A. Guillaudeu, research chemist, Swift & Co., and H. E. Robinson, assistant chief chemist, Swift & Co.

As an added feature this year, plans are being made for a national industrial chemical conference. The program for this conference is now being arranged with leaders in the chemical industry scheduled to deliver addresses.

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NEAR EASTERN COUNTRIES IMPORTANT IN PLANS FOR EXPANDING GERMAN CHEMICAL TRADE

Special Correspondence

EDITOR'S NOTE: *Cut off from direct correspondence with all except a few foreign sources in neutral countries, these notes interpret recent developments in continental Europe as reported in publications and official documents received in the United States. These monthly letters, prepared in this country, will be continued only so long as pertinent material of interest to American chemical industry is available for our comment and interpretation.*

WHILE the German military casts an eager eye on Turkey and the Near East for strategic reasons, the chemical industry is carefully studying the area as a potential market and source of raw materials, not the least of which, of course, is Near Eastern oil.

Turkey, which, for the past three decades, has wavered in its policy between joining with the Allies or Germany, at the outbreak of the war obtained roughly 50 percent of her chemical imports from the Reich, chiefly pharmaceuticals and heavy chemicals, and also rubber, dyes, rayon, plastics, and fertilizers. In 1940, when Turkey swung away from Germany, Italy went into first place as Turkey's leading chemical supplier, and Britain's chemical trade also increased.

Surveying Turkey's raw materials, the publication *Chemische Industrie* reports that if more fertilizer were used, agricultural yields could be increased considerably. As a matter of fact, the Anatolian coastal areas are among the most fertile in the Mediterranean region. The inland plateaus, despite a bad climate, could supply larger amounts of minerals and wool and mohair. The Turkish government has been active the past ten years in trying to develop Anatolian copper and chrome deposits, partly with the help of French and British capital. Modest amounts of coal and lignite are to be found, and future chemical development plans include coal liquefaction. Exploratory drilling for petroleum has not been too promising although good iron ore and manganese have been found. Turkey is one of the world's important chrome producers, and chromium figured prominently in the recent Turkish-German trade agreement.

The Near East as a whole, including Turkey, Cyprus, Egypt, Palestine, Iran, and Iraq, with a total population of around 70 million people, is viewed as an area whose agricultural and mineral resources could be better organized, according to Nazi plans. Heretofore these countries had to import four-fifths of their chemicals. In 1939-40, Germany supplied 61 percent of the medicinals imported by Turkey, and 70 percent of those imported by Iran, 42 percent of the dutiable chemical imports for Iran—considerable nondutiable imports of the Anglo-Iranian Oil Co. have come largely from Great Britain—were supplied by Germany, and 28 percent by the United States in the year 1939-40.

Iran has only a small infant chemical industry, although several larger state-subsidized chemical factories are planned, including a good-sized soda factory at Teheran. A sulphuric acid factory in Abadan, produces acid from imported sulphur, chiefly for oil refinery use. A government explosives plant near Teheran also produces sulphuric and hydrochloric acid. There are six match factories and several soap factories, the newest being at Ray near Teheran with a daily capacity of 30 tons of soap, 5,000 candles, and 2 tons of glycerine. There is little rose oil production, most of the roses being processed for rose water. Serums and vaccines are manufactured at the Pasteur Institute in Teheran. No opium alkaloids are produced domestically, although a considerable amount of raw opium is exported. The Ministry of Industry operates a tar distillation plant near Teheran to process heavy oils and road preparations.

Most important Iranian product, from the standpoint of the Reich, is oil. With an annual production of 10.5 million tons, equivalent to 3.5 percent of the world's total, Iran follows the United States, Soviet Union, Venezuela, and the Dutch East Indies in world oil output. Rumania's output is only 6.5 million tons. Of the 8.3 million tons of Iran exports of oil and derivatives in 1939-40, 3.4 million tons went to Great Britain, and 80 percent went to the British Empire when Dominions are included.

To facilitate shipments of Rumanian oil to the Reich, and to relieve congestion on the lower reaches of the Danube, it is reported that a pipeline is being laid from the great Rumanian oil center at Ploesti to the Iron Gates farther up the Danube. The reports state that the pipe is being obtained by dismantling the 250 mile pipeline running from the French port of Nantes to Paris and transporting it to Rumania.

With the coming of spring, river traffic on the Danube in specially constructed barges is becoming important again. The Nazis have announced a grandiose 40-Year Plan for unification of continental European waterways with Germany at the hub. It is planned to join the Danube with the Rhine and Main rivers, the Danube and Weser, the Danube, Neckar and Rhine, the Danube and Elbe, the Danube and Oder, Danube and Lake Constance. An announcement by the German Ministry of Communications and Posts indicates that plans have been

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made to join the German network with the French system of inland waterways.

With supplies of natural textile fibers unavailable, France is having to turn to synthetic production of staple fiber, which has been given the standard trade name "Fibranne" to parallel the earlier name "Rayonne." Under the direction of the Thueringsche Zellwolle A. G., Schwarza, France Rayonne is building a staple fiber factory in unoccupied France. The German company was also called in by Nazi military authorities to operate the rayon factory of Société Industrielle de Moy. Production of rayon in France this year is expected to reach 40,000 tons, and of "Fibranne" probably around 20,000 tons. Broom plant is also being processed in Dolomieu, France, to make a fiber resembling wool, which is mixed with rayon for blankets and inexpensive cloths. This plant, whose product can also be used in the flax and jute industry, expects to process 5,000 tons of fiber this year.

Another source of cellulose in Germany is potato tops. Improvements in collecting, cleaning, recovering, and processing the pototo-top cellulose have made it possible to turn out a fairly good quality paper, "Solanum," after the botanical name of the potato. The branch of the potato industry collecting these potato tops states that the potato cellulose structure differs from that of wood and straw and is closest to that of beech cellulose.

The effect of tin shortages has caused a striking reorganization of production of Germany's tin can industry. The number of articles in Reich technical journals indicates that the problem has by no means been solved, and that an economical and satisfactory substitute has not been found. One field where replacements of tin plating have caused difficulties has been in the manufacture of large farm milk containers. In the Reich the lacquer industry is experimenting with the production of shock-proof, oil-free paint or lacquer to line the large milk cans.

In the chemical apparatus field, I. G. Farben has patented several corrosion-resistant replaceable linings for chemical equipment. One process calls for linings made of coke or graphite, using tar or a similar material as a binder. The back of the lining is coated with a metallic layer such as electrolytically deposited copper, and is soldered to the inside wall of the iron apparatus. Its increased resistance to chemical corrosion is claimed to offset the fact that the heat conductivity of this lining is lower than that of a metallic lining.

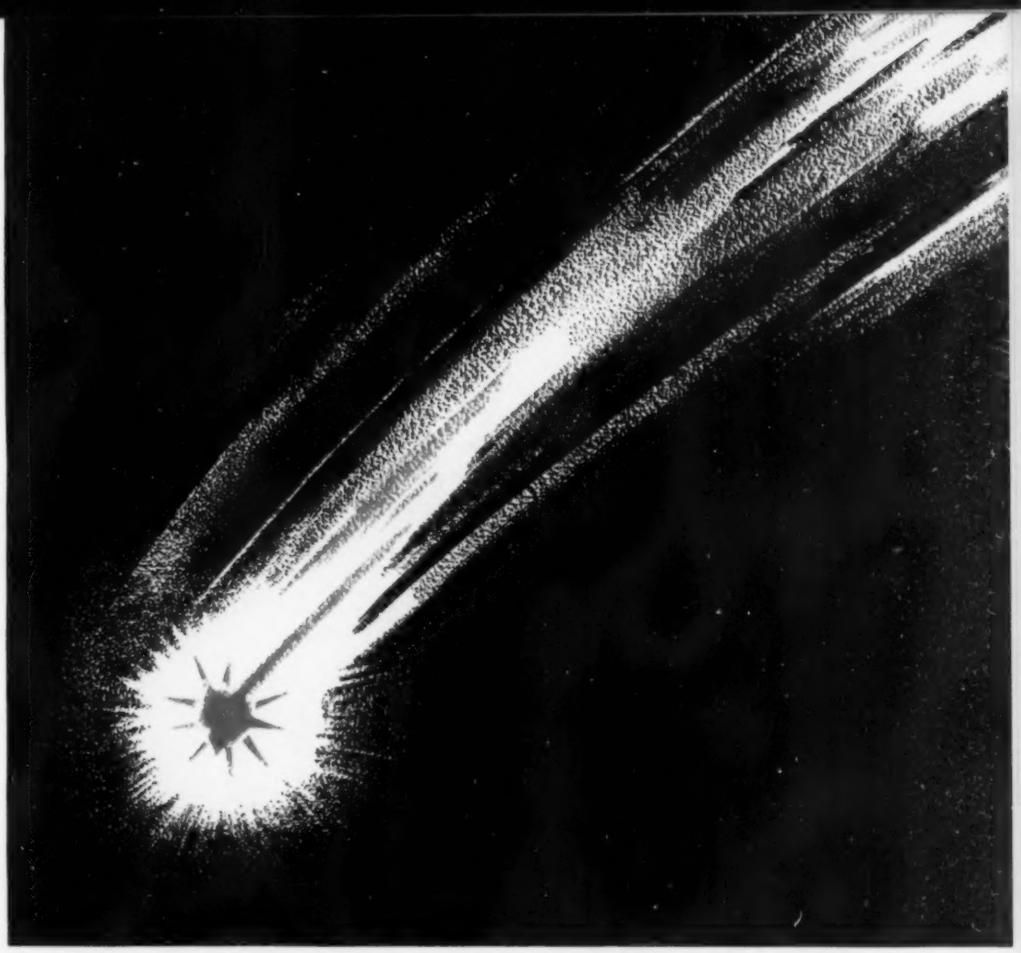
To prevent injurious action of the sulphur in rubber on copper conductors which are to be rubber-insulated, Siemens Shuckert Werke has patented a process calling for the electrolytic coating first of such copper wire with a tin-cadmium coating which can be applied in either an alkaline or acid bath before the rubber covering is applied.

Another replaceable lining for chemical equipment patented recently in Germany calls for ferro-silicon alloys fastened to apparatus walls by means of aluminum alloy solder. The connecting solder (aluminum 65 to 67 percent, tin 21 to 25 percent, copper 10 to 12 percent, together with some chlorides of potassium and sodium), is claimed to adhere well to the silicon alloy, and thereby obviate an additional metallic layer coating.

As light metal production increases in connection with the aviation industry, new uses are constantly being found for aluminum and magnesium alloys, which will undoubtedly be of importance when peace comes again. The possibility of using aluminum and magnesium in passenger car production is occasionally discussed in German engineering journals. Although figures are not comparable, it is interesting to note that the price of magnesium, first quality 1a, was lowered on Sept. 1 of last year from 1.90 RM to 1.80 RM per kilogram. This figure compares with a reduction in raw aluminum from 1.60 RM in 1934, to 1.33 RM in 1937, to 1.27 RM at present. Whereas aluminum prices might increase some time in the future as higher grade bauxite deposits might become exhausted, the raw materials for magnesium, both natural ores and sea water, are relatively inexhaustible.

To conserve metal supplies for more vital wartime needs, plastics are being constantly improved in the Reich. At a recent exhibit in Zurich, Switzerland, new German products displayed included the non-inflammable celluloid substitute "Cellon," which has a wide range of application, including the manufacture of gas masks. "Trolitax," a synthetic resin impregnated paper of high dielectric value used in the construction of transformers, electric motors, etc., was exhibited along with the phenolic resinoid "Trolitan," used in electric insulation. Samples of "Trolit" and "Trolitul," two die cast synthetic materials used in machine and apparatus construction, were also featured, together with "Lignofol," a substitute for hard tropical woods, and "Pollopas," a urea-formaldehyde plastic.

Synthetic rubber problems discussed before a recent meeting of the Deutsche Kautschuck Gesellschaft in Berlin include that of trying to produce a non-fading, tasteless, and odorless Buna. A recent I. G. product, "Renacit," an aid in plasticizing "Perbunan" and reclaiming "Buna S" and "Perbunan," was also discussed. In the milling process, a softener, such as "Plastikator RA," is used with "Renacit." The latter has one drawback in that in some cases it causes skin irritation when manufactured into products coming into contact with the skin. To overcome this, a new product, "Renacit II," is soon to be marketed. It is said to contain paraffin combined with a substance related to the original "Renacit," but less irritating.



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PERSONALITIES

✦ M. R. BHAGWAT is now with Mathieson Alkali Works at Niagara Falls, N. Y. Mr. Bhagwat had been associated with the Chemists Advisory Council of New York and its predecessor, the Committee on Unemployment and Relief for Chemists and Chemical Engineers, for the ten years that the organizations operated. Mr. Bhagwat is a chemical engineering graduate from Fergusson College of Bombay University and from Columbia University. He was graduated from the latter in 1923. He has served with the National Aniline & Chemical Co. and Combustion Utilities Corp.

✦ JOHN A. FINLEY has been named research engineer on the technical staff of the Battelle Memorial Institute, Columbus, Ohio, and has been assigned to research in metallurgy. A graduate of Michigan College of Mines and Technology, Mr. Finley was associated with the Carnegie-Illinois Steel Co., prior to joining the Battelle staff.

✦ HAROLD W. WHITE has joined the research and development staff of Bakelite Corp., Bloomfield, N. J. Mr. White is a graduate of the University of Alabama with a B.S. degree in chemical engineering.

✦ FRANCIS B. HILLHOUSE has been appointed to the chemicals staff of the Bureau of Foreign and Domestic Commerce. Born in New Haven, Conn., Mr. Hillhouse received a B.A. degree from Yale University in 1925. He was employed by the National Aniline & Chemical Co. from 1927 until his appointment to the Bureau of Foreign and Domestic Commerce. He spent several years in China and Japan representing the National Aniline & Chemical Co. in the sale of dyes. Mr. Hillhouse will be associated with J. N. Taylor, in the Organic Chemical Section and will serve under C. C. Concannon, chief of the chemicals staff and industrial consultant on chemicals.

✦ LUDWIG ROSENSTEIN, formerly of Shell Chemical Co., is now associated with General Chemical Co.

✦ CHARLES C. CONCANNON becomes chief of the Chemicals Section of the Durable Goods and Materials Unit of the Bureau of Foreign and Domestic Commerce in the reorganization of the division which has just taken place. Thomas W. Delahanty becomes chief of the reorganized Public Utility and Service Industries unit of that organization.

✦ GEORGE A. FOWLES has been appointed a sales engineer in the synthetic sales division of The B. F. Goodrich Co. with cable and wire insulation problems as his special field. He was graduated from Massachusetts Institute of Technology as a bachelor of science in electrical engineering.

✦ ROBERT D. WILLIAMS has been named a research engineer on the technical staff of Battelle Memorial Institute, Columbus, Ohio, where he will assist in the Institute's welding research. Prior to joining Battelle, Mr. Williams was a member of the faculty in the department of mechanical engineering at the University of Illinois. He is a graduate of Harvard University and of Massachusetts Institute of Technology.

Louis A. Hoffman

✦ LOUIS A. HOFFMAN has been elected president and general manager of the Hilton-Davis Chemical Co. of Cincinnati. He succeeds A. B. Davis, who died on March 11. Mr. Hoffman has been associated with the company since its inception in 1922, first as research chemist and since 1936 as vice-president and treasurer. Mr. James F. Thompson, Jr., was elected vice-president in charge of research and Mr. George Nieder as vice-president in charge of sales. Both have been associated with the company for many years.

✦ HUGH A. SHADDUCK has resigned his position with the Owens-Illinois Glass Co. in order to join the Harshaw Chemical Co., Cleveland, Ohio.

✦ PAUL D. PETERSON has been appointed director of agricultural research for the Freeport Sulphur Co. to head the company's development of new agricultural uses of sulphur. Dr. Peterson has specialized in research on agricultural uses for the past 10 years. His experience includes work with Freeport, the Crop Protection Institute, the Office of Cereal Crops and Diseases of the Department of Agriculture and the Koppers Co. He holds bachelor and doctor degrees from the University of Minnesota and he has taught plant pathology there and at Cornell. Headquarters will be in the New Orleans office.

✦ J. B. WIESEL, director of sales of the Cellulose Products Department of Hercules Powder Co. has been appointed advisor to J. B. Davis, chief of the Protective and Technical Coating Section of the War Production Board. He will have charge of the allocation of nitrocellulose and ethyl cellulose. Mr. Wiesel will devote half his time to the work in Washington and half to his work with Hercules.

✦ J. D. VAN VALKENBURGH has been appointed assistant to the president of Irvington Varnish & Insulator Co., Irvington, N. J. For the past several years Mr. Van Valkenburgh has been associated with the Johns-Manville Corp., New York.

✦ J. O. SMALL, formerly vice president and technical director of Arco Co., Cleveland, Ohio, has joined the Synthetics Department of Hercules Powder Co., Wilmington, Del. He will be engaged in technical development work in the use of synthetic resins and rosin esters, particularly in their application to war materials. Mr. Small had been associated with the Arco Co. for the past six years. From 1925 to 1936 he was associated with Devoe & Reynolds Co. in paint and lacquer operations and later was manager of their industrial research laboratories. After obtaining his B.S. and M.A. degrees from Dickinson College, Mr. Small's first position was with Hercules Powder Co. at their Parlin and Kenvil, N. J., plants. He was for a time nitrocellulose superintendent at Parlin and subsequently chief chemist at this plant.

✦ GEORGE P. TORRENCE, chief engineer of Industrial Rayon Corp. and vice president and general manager of its subsidiary, Rayon Machinery Corp., has been named chief of the Materials Disposition Section of the Inventory and Requisitioning Branch of the War Production Board. Mr. Torrence, who is also a director of the Industrial Rayon Corp. of Cleveland and was formerly president of the Link-Belt Co. of Chicago, will have responsibility for disposing of surplus materials in hidden or excessive inventories.

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✦ HAROLD R. MURDOCK, who has for the past several years been director of research of the Pulp Division of the Champion Paper & Fibre Co., now has the additional responsibility of vice president and general manager of the Hamilton Laboratories, Hamilton, Ohio, subsidiary of the Champion organization. These laboratories produce phenyl mercuric compounds, both the technical and medicinal grades. Mr. Murdock will spend most of his time in Hamilton.

✦ ROZIER D. OILAR, chemical engineering consultant specializing in vegetable and animal oils and fats, is in Ecuador, where he is putting a plant in operation. During his 50 years in this field he has installed and operated edible oil plants in Barbadoes, B.W.I., Venezuela, Colombia, Ecuador, Peru and Chile, besides in some five parts of Mexico, and the United States. Mr. Oilar expects to return to his home at West Lafayette, Ind., snortly.

✦ JACK LEMAY, chemical engineer in the research department of the Springfield, Mass., plant of the Monsanto Chemical Co., has been transferred to the Merrimac division of the company, Cambridge, Mass. C. Emerson, Jr., chemist in the control department of the Springfield, Mass., laboratory of Monsanto Chemical Co., is now in the Merrimac division, Cambridge, Mass. A. B. Gerber, chief chemist of the Anniston, Ala., plant of the Monsanto Chemical Co., has been transferred to the Trenton, Mich., plant.

✦ L. E. WETZELL is now manager of the Cleveland, Ohio, branch office of General Controls Co., Glendale, Calif. Mr. Wetzell is a graduate engineer of Purdue University and for the past several years has been actively engaged in sales engineering work for the company.

✦ W. L. WHITE, director of laboratories for the Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc., Passaic, N. J., is now assistant factory manager. Mr. P. A. Cady has assumed the responsibilities of laboratory manager.

✦ JOHN R. HOOVER has been appointed manager of synthetic rubber sales of the B. F. Goodrich Co. He succeeds Dr. H. E. Fritz, who was recently made director of research. Mr. Hoover has been manager of rubber-lined equipment sales since 1935 and is succeeded in that post by Herman C. Klein, who has been sales engineer in the department. Mr. Hoover was born in Little Falls, Minn., and graduated from high school in Boise, Idaho, and received his bachelor of science degree in chemistry from Harvard in 1924. Joining Goodrich in 1925, Mr. Hoover started in the general chemical laboratories, later was in the technical and production departments of the boot and shoe division, and manager of the general

chemical laboratory until he was named sales engineer in the rubber-lined equipment department in 1931, becoming department manager four years later. Mr. Klein graduated from the Vincennes, Ind., high school and received his bachelor of science degree in chemical engineering from Purdue University in June 1929, joining Goodrich the following August. He remained in the company's laboratories one year and then became sales engineer in the department he now heads.

✦ S. L. SWASEY, who has been chief chemist at the Pasadena, Houston, Tex., mill of Champion Paper & Fibre Co. is now technical specialist for the Pulp and Paper Section of WPB, Washington.

✦ HENRY A. SALLER has been named a research engineer on the technical staff of Battelle Memorial Institute, Columbus, Ohio, and has been assigned to research in metallurgy. A graduate of Purdue University, Mr. Saller was associated with Carnegie-Illinois Steel Corp. prior to joining Battelle.

✦ A. E. MARSHALL, president of Rumford Chemical Works, Rumford, R. I., has been elected to the additional post of Chairman of the Board. Mr. Marshall became president of the company Jan. 1, 1939.

✦ NOEL R. PHILLIPS has joined the R. T. Vanderbilt Co., at East Norwalk, Conn. He will serve the company in its research laboratories.

✦ HENRY C. BARNETT, who received his degree in chemical engineering from the University of Virginia in 1941 and later was employed by the Virginia Chemical Corp., Piney River, Va., is now doing chemical engineering research work in connection with aviation motor fuels at Langley Field, Va.

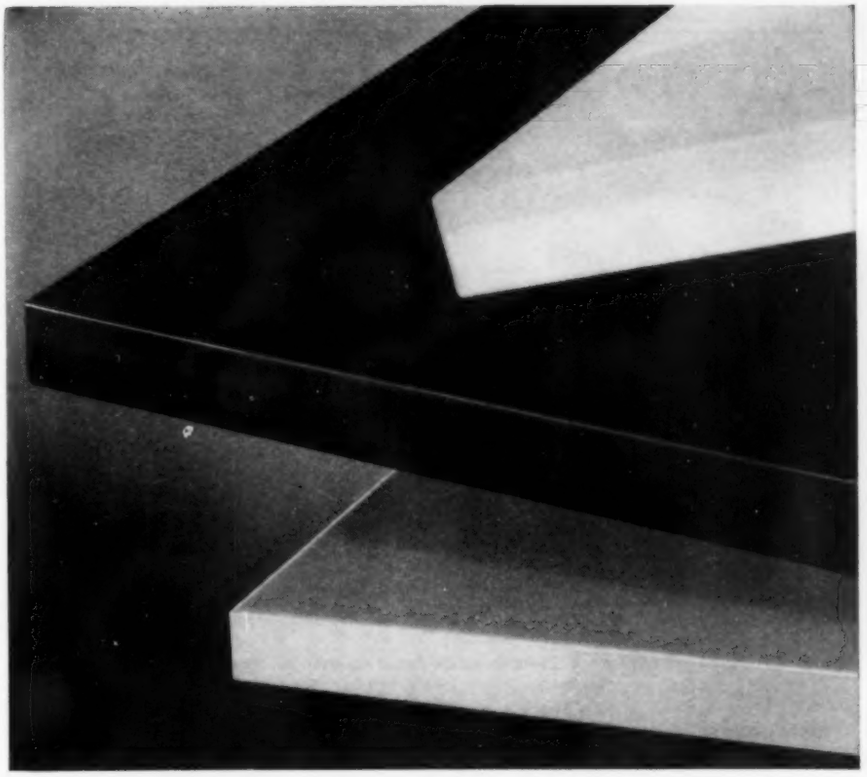
✦ GRANVILLE E. ZIMMER of the University of Wisconsin and Charles J. Domke of Loyola University have recently become associated with the research staff of Standard Oil Co. of Indiana at Whiting.

✦ W. E. KRUSE, who for some time has been connected with the Standard Oil Co. of Indiana, has resigned to accept a position with the Celotex Co., Chicago, Ill.

✦ WILBUR MCPHERSON, a 1941 graduate of the University of Kansas is now in the research division of Hercules Powder Co., Wilmington, Del.

✦ ARTHUR J. ROBERTS, a graduate of the chemical engineering department, University of Wisconsin, is now with Procter & Gamble, Cincinnati, Ohio.

✦ O. W. BALDWIN becomes chief chemist of Gary Works of the U. S. Steel Corp.



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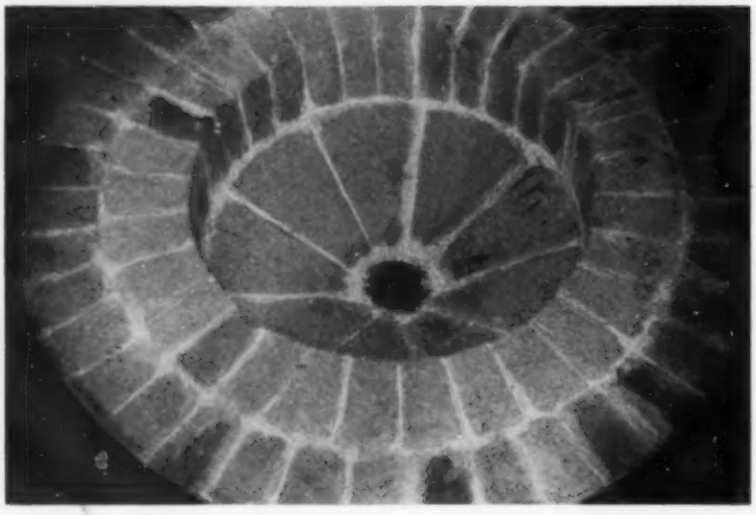

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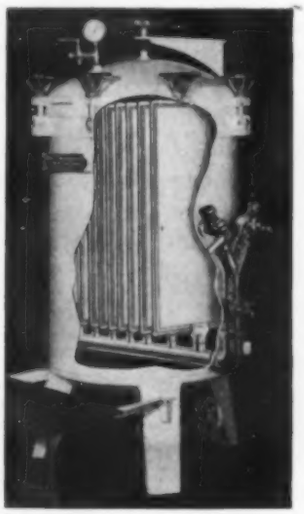

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✦ PAUL TORRE, who was formerly connected with the DeZurick Shower Co., is now with the North American Pulp & Paper Co., Sheboygan, Mich. He is chief chemist for the paper company.

✦ CLAUDE F. DAVIS has joined the Schwarz Laboratories, New York, N. Y., as chief chemist. Mr. Davis is a graduate of Oklahoma A. & M. and comes to the Schwarz organization with a background of association with the Western Star Milling Co. of Salina, Kans., The Noblesville Milling Co., Noblesville, Ind., and Michigan Bakeries, Grand Rapids, Mich.

✦ CHRISTY VANDER VALK, who received his degree from the chemical engineering department of Pratt Institute, Brooklyn, N. Y., in 1940, is now a research chemist for Heyden Chemical Co., Garfield, N. J.

✦ F. P. MCKEGNEY, formerly assistant chief engineer of Air Reduction Co., New York, N. Y., has been appointed chief engineer.

✦ FRANK E. MAPLE has taken over the handling of technical service and market development activities in connection with the introduction of new chemicals, particularly nitroparaffin, for the Commercial Solvents Corp., Terre Haute, Ind. Mr. Maple is a graduate of the University of Illinois and has been with Commercial Solvents since 1936 in their production research and trade relations division.

✦ HOMER L. SHAW has been appointed a research engineer on the technical staff of the Battelle Memorial Institute, Columbus, Ohio, and has been assigned to research in metallurgy. A graduate of Muskingum College, Mr. Shaw was associated with the Jones and Laughlin Steel Corp., prior to joining the Battelle staff.

✦ ROBERT M. KEENEY, since 1939 industrial manager of the Connecticut Light & Power Co., has been appointed assistant chief, Nickel Branch, Materials Division of the War Production Board, Washington, D. C. Mr. Keeney attended the Massachusetts Institute of Technology and the Colorado School of Mines.

✦ HARRY F. NEWMAN, who graduated with a degree in chemical engineering from Illinois Institute of Technology in 1940, is now employed as engineer with the Standard Oil Co. of Indiana, Chicago, Ill.

✦ JAMES F. VANECEK is now employed by the Standard Oil Co. of Indiana. He was with the Illinois State Geological Survey from 1938 to 1941 and with Merck & Co., Inc., Rahway, N. J., for several months before joining Standard Oil.

✦ EDWARD M. ENGLE is with General

Chemical Co., Edgewater, N. J., where he serves as technical service engineer.

✦ FRED C. DIETZ, who received his Ph.D. degree from the University of Illinois in 1941, is now employed as research chemist with General Aniline and Film Co., Grasselli, N. J.

✦ JOHN V. CRAMER, who graduated in 1939 from the Missouri School of Mines, is at Sheffield, Ala., where he is employed by the Alabama Bauxite Co.

✦ WILLIAM F. ZIMMERLI has been appointed vice president in charge of research and patents of General Aniline and Film Corp. Dr. Zimmerli, a graduate of Polytechnic Institute of Brooklyn, also holds a degree from Heidelberg University. Since 1939 he has been head of the development department of the du Pont company.

✦ JOSEPH S. BATES has been appointed vice president in charge of production for General Aniline and Film Corp. Mr. Bates is a graduate of Yale University. In 1924 he established the Bates Chemical Co. Since last October Mr. Bates has been chief of the Coal Tar and Intermediates Section of the Chemical Branch of W.P.B.

✦ L. V. STECK is vice president in charge of marketing of Shell Chemical Co. Mr. Steck is a graduate of the University of California. He joined the staff of Shell Development Co. in 1930. He was assistant director of the laboratories until he began his new duties with Shell Chemical Co.

✦ GEORGE E. SCHNEIDER has been elected general manager of the Association of Commerce New Orleans. Mr. Schneider succeeds Mr. H. Van R. Chase, who passed away recently.

IN THE ARMED FORCES

✦ ROBERT EDWARDS, who has been serving with the Monsanto, Ill., plant of Monsanto Chemical Co., has been called to active service. First Lieutenant Edwards has been technical assistant for the company. He is now with the Chemical Warfare Service.

✦ M. H. VAUGHAN, on April 1 joined the Ordnance Department at Aberdeen Proving Ground as a first lieutenant. After graduating from Virginia Military Institute in 1933 Lieutenant Vaughan spent eight years in the sulphate pulp and paper industry. In January 1941 he left the Halifax Paper Co., Roanoke Rapids, N. C., to accept a position with the R. & H. Department of Du Pont as production supervisor.

✦ VIRGIL F. PAYNE, professor of chemistry at Transylvania College for 19 years, left March 15 to serve as a chemist with the Signal Corps laboratories at Fort Monmouth, N. J.

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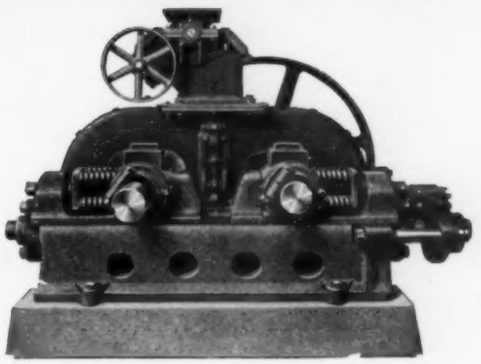

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12" x 12"	.75"	.25"	7.4	.25"	.125"	3.7	.125"	.032"	.94
20" x 14"	1.59"	.75"	43.5	.75"	.2"	13.7	.25"	.065"	5.32
24" x 15"	2."	1."	56.5	1."	.25"	17.15	.5"	.125"	10.
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✦ RICHARD W. BUCKER, supervisor of the synthetic nitric and bisulphite departments of the Everett, Mass., plant of Monsanto Chemical Co., has left the organization. Lieutenant Bucker is now on active duty with the Engineering Corps of the Army.

Donald E. Cable

✦ DONALD E. CABLE, who has been employed by the U. S. Rubber Co. during the past 12 years, first as assistant to general manager of fiber products department at Cleveland, Ohio, and since May, 1931, at the general laboratories at Passaic, N. J., has been called into military service. On March 27 he left Passaic for Texas where he will be stationed with the Dallas Chemical Warfare Procurement District. Captain Cable was at one time assistant director of the Oxford Paper Co.'s research department.

✦ WLLIAM B. LAUDER, until recently connected with the Mutual Chemical Co. in Jersey City, N. J., has now joined the U. S. Army. Mr. Lauder obtained his chemical engineering degree from Massachusetts Institute of Technology in 1935.

✦ JOHN A. RIDDICK and GEORGE E. HINES of the Commercial Solvents Research Department recently reported for active duty with the Army.

✦ THOMAS R. KURTZ, manager of Shell Oil Co.'s marketing operations department, has been assigned to the staff of Admiral Adolphus Andrews of the Third Naval District, New York. In the last war he was the youngest officer to hold the rank of captain and was chief of staff of Admiral Wilson, Commander of Naval Service in France. He was commandant of the Naval Academy from 1921 to 1924. Charles E. Smith, former division manager of Shell's Baltimore Division, has been assigned to the Office of Chief of Naval Operations in Washington. In the last war Captain Smith had command of a destroyer flotilla and later was director of athletics at the Naval Academy.

OBITUARY

✦ HERMAN ELISHA BROWN died March 20 at his home in Highland Park, N. J., of pneumonia after an illness of four weeks. His age was 73. Two months ago Mr. Brown organized the Brown Laboratories, a firm intended for the production of iodine compounds and other chemicals. He had specialized for the last ten years in bacteriological chemistry.

✦ FRANCIS IRENEE DU PONT, senior partner of the New York Stock Exchange firm of Francis I. du Pont & Co. and Chisholm & Chapman, died at the West Side Hospital, New York, March 16. Mr. du Pont was born Dec. 3, 1873 at Wilmington, son of the late Francis Gurney du Pont, one-time acting president of the E. I. du Pont de Nemours & Co. He entered the class of 1894 at the University of Pennsylvania and from there transferred to the Sheffield School at Yale University, from which he was graduated in 1895. After serving with the du Pont Company for a number of years, he entered the financial field in 1931 by founding the brokerage firm bearing his name.

✦ EDWARD T. FISHWICK, vice president and director of the Worthington Pump & Machinery Corp., died March 15 at his home in Glen Ridge, N. J. Mr. Fishwick had been with the Worthington organization for 49 years, having started with the corporation at its Cincinnati works.

✦ WILLIAM A. WITHINGTON, former superintendent of the Standard Portland Cement Co., Leeds, Ala., and more recently with the Universal Atlas Portland Cement Co., passed away on March 9 at Natchez, Miss. Mr. Withington was born in Charleston, S. C., in 1869. In 1904 he was sent to Leeds, Ala., to erect a plant for the Standard Portland Cement Co., of which plant he eventually became general superintendent. When, several years later, the plant was acquired by Universal Atlas Cement Co., he was retained by the new owners as local purchasing agent. He was a pioneer in the cement industry in the South and was responsible for many improvements in quarrying and plant operation.

✦ LLOYD B. EDGERTON, vice president of the Philadelphia Quartz Co., Philadelphia, Pa., died March 15 at the Presbyterian Hospital in Philadelphia after a long illness. He was 55 years of age. Born in Barnesville, Ohio, Mr. Edgerton graduated from Ohio State University with the class of 1909. After obtaining his degree of mechanical engineer, he was associated with General Electric Co. at Schenectady. In 1913 he entered the employ of the Philadelphia Quartz Co., assuming charge of the engineering department. He was appointed works manager in 1930, director in 1934, and vice president in 1935.

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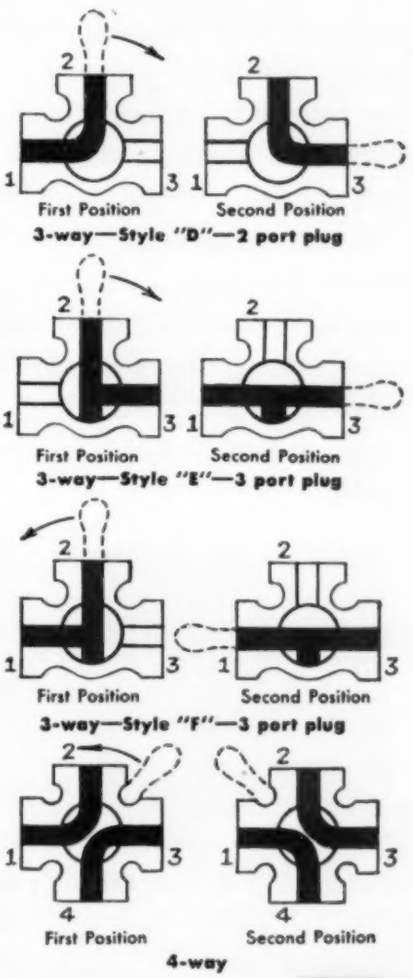

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NEWS OF PRODUCTS AND MATERIALS

SPERM AND COCONUT OIL SUBSTITUTES

Substitutes for sperm oil and coconut oil, two vital defense materials, which have been placed under full priority by the government, have been produced by leather chemists of the National Oil Products Co., Harrison, N. J. The substitute for sperm oil called "Tanoyl 1269, is in many respects superior to the actual sperm oil for tanning purposes. It is said to have all the necessary tanning qualities demanded of the oil of the sperm whale and in addition is made from vegetable oils of American origin, eliminating dangers of government priorities and shortage of supplies.

The replacement for coconut oil, Tanoyl 1230R, has the identical non-oxidizing qualities required in fat liquoring white leather where any slight oxidation will cause a yellowing of the leather which would make it unsatisfactory for use. It has been stated that in actual use the new oil substitutes have proved so effective, it is doubtful whether sperm and coconut oils will be able to reestablish themselves in the tanning industry after hostilities cease and supplies are once more available.

SYNTHETIC FATTY ACID

The specifications for Palmalene, a new synthetic palm fatty acid of medium titre, make it suitable for many uses. It is especially suitable for textile specialties, soap making, alkyl resins, polishes, wetting agents, cosmetics, rubber compounding, kier assistants, driers, and pulp and paper manufacture. The Palmalene specifications are as follows: saponification number—180-185, iodine value 55-60, titre 35.

METAL CLEANER

A fluid that conditions all metals, stops oxidation, and makes paint coats last longer, has been given the name Deox-X by Protective Coatings Inc., Detroit, Mich. It is used cold. However, it may profitably be heated for more rapid removal of oil. Application may be by dipping, brushing, spraying or sopping with a dampened cloth. Metals may be treated with this material and placed in stock or shipped prior to the paint coat. It cleans all metals of oil and corrosion, inhibits further corrosion for a practicable period, that is weeks or months prior to finishing, painting, enameling, etc. It saves sand blasting and pickling, and is said to reduce the cost of preparation of the metal.

TOLUOL SUBSTITUTE

A hydrocarbon solvent, high in aromatics, which is finding favor in commercial applications by industrial users as an important toluol substitute, has been given the name Notol No. 1 by the Neville Co., Pittsburgh, Pa. This solvent like the company's Tollac solvent, is produced in accordance with specifications of the U. S. Patent 2,229,328. The nitrocellulose tolerance of Notol No. 1 is within 80 percent of that of toluol, hence it may be used with slight change in formulation as an effective substitute for toluol. In some instances, it may be found that the slightly more rapid initial evaporation will necessitate the use of small additional amounts of butyl or amyl alcohols to prevent formulation calling for Ennjay No. 1 or Solvesso No. 1. Specifications for Notol No. 1 are evidence that this product is a satisfactory lacquer diluent for use in the lacquer industry under present wartime conditions.

LUMINOUS BLACKOUT PAINT

A luminous blackout paint which can be applied to objects of all kinds and renders them visible in the dark, has been developed by Maas & Waldstein Co., Newark, N. J. Unlike the radioactive finishes commonly used on watch dials, the new paint owes its luminosity to a substance which reradiates light, according to the manufacturer. It contains no toxic materials. After the paint has been exposed to either daylight or ordinary electric illumination for a few minutes, it glows for about 20 hr. and repeats the action after re-exposure. The new paint which is known as Durad luminous paint, must be used over a special primer and thinned out with a special thinner, both of which are supplied with the paint. One thick coat, or preferably, several thin coats of the paint produces a flat white finish suitable for indoor service. For glossy finish or for outdoor service, the paint is covered with a special clear topcoat. Each coat air-dries in about 1 to 4 hr. depending upon the weather and other conditions.

CAMOUFLAGE PAINT

Specular reflection of mirror-like surfaces such as glass windows can be immediately neutralized or deadened by a new material devised by the Truscon Laboratories, Detroit, Mich., to which has been given the name of VD Glaze (VD stands for visual deception). This glaze has a useful property of immediately blotting out the reflection from specular surfaces. It may be applied to glass, steel, concrete, brick, terra cotta, overpaint, etc. The tops of automobiles parked in great numbers around an industrial plant are a dead give-away so far as reflection by day or night is concerned. A coat of VD glaze applied to the car tops immediately kills all reflection as effectively as though covered with a blanket. It is made in a clear white translucent, designated as "white sand," and tints. The tints are made to simulate the standard army camouflage colors. That is to say, though the tints of VD glaze are translucent and admit daylight, yet when viewed

AID THE VICTORY PROGRAM!

AN IMPORTANT NOTICE

To Users of General Chemical Nitric Acid and Acetic Acid

Because of the critical shortage of containers, users of General Chemical Nitric and Acetic Acids are *urgently* requested to order the following high strength acids instead of lower strength acids:

NITRIC ACID—42° Baume
ACETIC ACID—80% or 84%

This will immediately release a large number of returnable carboys and barrels for use in filling vital war orders.

In addition to aiding the common war effort, you will gain these advantages:

- **More Prompt Delivery**—due to standardization in filling orders.
- **Reduced Handling Charges**—because you handle fewer containers.
- **Less Money Tied Up in Carboy or Barrel Deposit Charges.**
- **Savings in Freight.**

Information on the dilution of these acids is given below. Your nearest General Chemical Company sales office will be glad to supply you with any additional data required.

GENERAL CHEMICAL COMPANY
40 RECTOR STREET, NEW YORK, N. Y.

Sales Offices: Atlanta • Baltimore • Boston • Bridgeport (Conn.) • Buffalo • Charlotte (N. C.) • Chicago • Cleveland • Denver • Detroit • Houston • Kansas City • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh • Providence (R. I.) • St. Louis • Utica (N. Y.)
Pacific Coast Sales Offices: San Francisco • Los Angeles
Pacific Northwest Sales Offices: Wenatchee (Wash.) • Yakima (Wash.)
In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

Tear Out and Use This Dilution Table

NITRIC ACID DILUTION TABLE ⇨

80% and 84% ACETIC ACID DILUTION ⇩

Both 80% and 84% Acetic Acids can be diluted to any desired weaker concentration by adding them to water. Calculations should be made on a direct percentage basis by weight.

AMOUNTS OF WEAKER STRENGTHS PRODUCED FROM 1 GALLON OF 42° BAUME

42° Baume Nitric Acid may be diluted to 36°, 38° and 40° Baume strengths as follows:

42° NITRIC ACID		WATER		DILUTED ACID
1 gallon	added to	3.2 pints	equals	36° Baume
1 gallon	added to	2.1 pints	equals	38° Baume
1 gallon	added to	1.1 pints	equals	40° Baume

AMOUNTS OF WEAKER STRENGTHS PRODUCED FROM 100 POUNDS OF 42° BAUME

42° NITRIC ACID		WATER		DILUTED ACID
100 lbs.	plus	28.5 pounds	equals	128.5 lbs. 36° Baume
100 lbs.	plus	19.0 pounds	equals	119.0 lbs. 38° Baume
100 lbs.	plus	9.5 pounds	equals	109.5 lbs. 40° Baume

7 VITAL LINKS
IN THE
STRUTHERS WELLS
CHAIN OF PROGRESS
TIME-PROVED
CRAFTSMANSHIP
PRACTICAL
DESIGNING
CONSTANT
RESEARCH
UNFAILING
LOYALTY
UNEXCELLED
FACILITIES
CONTINUOUS
INSPECTION
CLASS 1
WELDING
A CHAIN is only as strong as its weakest link! Here at Struthers Wells we have forged each and every link in our Chain of Progress with such infinite care and precision as to defy destruction. These Seven Vital Links constitute the culmination of years of painstaking effort to build one of the country's finest organizations for designing and fabricating chemical process equipment. ● Right now, of course, the entire Struthers Wells capacity is being devoted to war production, and new problems are being encountered and successfully solved, thus adding to our store of knowledge and ability to serve you better. Remember, when final and complete Victory is achieved . . . as it surely will be . . . you will want to call upon Struthers Wells skill and experience to help you with your post-war processing problems. Then—as before—the Seven Vital Links of S-W progress will be yours to command.
STRUTHERS WELLS CORPORATION
WARREN, PENNSYLVANIA

from the outside, the glass appears to be opaque. Thus colors of VD glaze can be selected to conform to the camouflage scheme used on a building to have the glass areas appear to be part of buildings or roof areas, or to merge into the surrounding terrain. VD glaze used in conjunction with blackout curtains, screens or panels, provides the triple function of (1) providing daylight to building interiors when daylight is wanted; (2) eliminating outside glare from windows under moonlight or flares; (3) presenting an opaque aspect when viewed from the outside, which blends in with the camouflage of visual deception scheme of the surrounding areas.

CHEMICALS

Thioglycolic acid, sodium thioglycolate, monoethanolamine thioglycolate, and calcium thioglycolate are now available in commercial quantities according to the Martin Laboratories, New York, N. Y. For the first time the materials, so indispensable in modern methods of hair waving, are produced especially for the cosmetic trade; also the fur industry and the woolen textiles.

PHENOLIC MOLDING COMPOUND

A new phenolic molding compound having a very low power factor and high dielectric breakdown and fatigue has recently been introduced by Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y. This material was especially developed for radio parts as condensers, crystal holders, etc. It has been designated as Durez 11863 and is said to have excellent moldability, being easy to handle in compression molds. Durez 11863 is available in one color—natural.

TUBING

Tubing designed for use as electrical insulation by manufacturers in the electronic, instruments, aircraft, electrical appliances and power industries, has been given the name of Fibronized Koroseal tubing by the Irvington Varnish & Insulator Co., Irvington, N. J. This new insulation was developed by Irvington's Fibron Division from Koroseal. The advantages of this material include inside and outside smoothness, exceptional elasticity and close manufacturing tolerances. It has excellent resistance to acids, alkalis, solvents and heat. It is fireproof and possesses an insulation resistance of infinity after 16 hr. of 90 percent of R.H. and 105 deg. F. As a result of A.S.T.M. test of being subjcted to 225 deg. F. for approximately 1,000 hr., it was found to have retained its flexibility. It has a tensile strength of 2,845 lb. per sq.in., a dry dielectric strength (.022 in. wall thickness) of 1,050 v.p.m., a wet dielectric strength (.022 in. wall thickness) of 817 v.p.m. after 24 hr. immersion.

REFLECTORS

Plastic disks about the size of a nickel, which are said to give maximum reflection of light from minimum

candle power are the latest contribution to blackouts by the E. I. du Pont de Nemours & Co., Wilmington, Del. Reflecting sharply the light from a blackout colored flashlight or similar shaded source, the disks may be worn on belts, armlets and clothing, or used as directional signals and signs of danger spots such as stairways, elevator shafts and the like. Made wholly of Lucite, methyl methacrylate resin, each disk has a hole in the center and may be nailed, riveted, screwed or wired in place almost anywhere. Available in crystal, amber, red and green, tests show that the tiny reflectors stand up under constant weathering, and are practically unbreakable. They are light in weight, as many as 600 being fabricated from 1 lb. of Lucite molding powder. A sign on the side of a truck made from these disks, for example, would serve the double purpose of warning a motorist approaching the truck at right angles at a crossroad and of advertising the truck owner.

SWEEPING COMPOUND

Industry more than ever is obligated to reduce hazards that cause fire. Spills of oil and grease accumulating on floors are a frequent source of fire. Carey grease ball asbestos sweeping compound effectively removes oil and grease deposits from floors and driveways. This inexpensive asbestos compound contains no acids or caustics and will not cause erosion. It eliminates the danger of slipping and fire hazard due to oil and grease accumulations.

Grease ball compound is readily applied by sprinkling it on the deposit. Heavy grease may first require soaking with kerosene. Scrubbing with a broom causes absorption of the oil and grease which can then be swept away. A further advantage of this compound is that it can be re-used until thoroughly soaked. This product is recommended by the manufacturers for garages, filling stations, factories, refineries, power plants, etc., where oil and grease spillage occurs. Grease ball asbestos sweeping compound is manufactured by the Philip Carey Mfg. Co., Cincinnati, Ohio.

RUBBER PLASTICIZERS

Two new synthetic and reclaimed rubber plasticizers are now available to fit the requirements of the industry. With these new materials, synthetics and reclaims can be plasticized economically and effectively. There is no extrusion from the stock, and 4½ to 10 percent gives an equal flexibility to approximately 25 percent dibutyl phthalate.

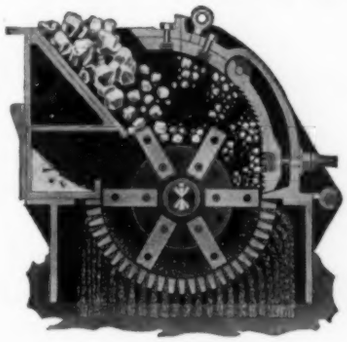
The Bunnatols G and S also act as wetting agents for pigments. They allow a minimum of milling and grinding for maximum dispersion throughout the stock. Both materials are insoluble in mineral and vegetable oils, giving the finished rubber a greater resistance to grease and oils. They must be added slowly in small portions when using.

WILLIAMS

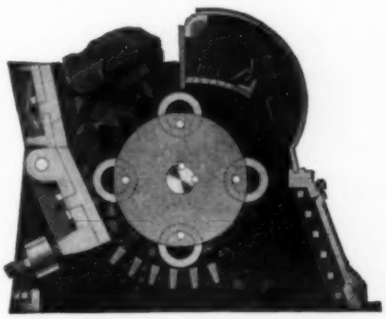
HEAVY DUTY HAMMER MILLS

..... *FOR INDUSTRIAL USE*

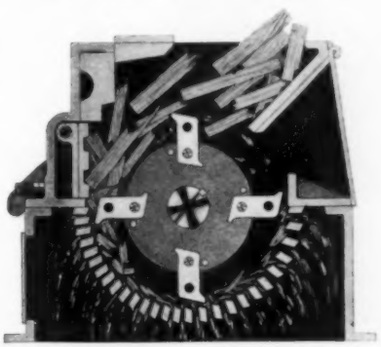
THOUSANDS OF SUCCESSFUL INSTALLATIONS . . . GRINDING *Every* MATERIAL



Sectional view of Williams "NF" type Hammer Mill used for limestone, steel-turnings, chemicals, garbage, expeller cake, etc.



Sectional view showing Williams Ring type Coal Crusher for making stoker coal, domestic sizes, etc.



Sectional view of Williams "No-Nife" Hog type Shredder used for wood refuse, tan bark, chips, etc.

- *ANIMAL*
- *MINERAL*
- *VEGETABLE*

Each year more manufacturers are recognizing the value of Hammer Mills in their material reduction jobs. The fact that Williams has pioneered the Hammer Mill and has been foremost in its development speaks for itself. The machines shown here represent the accumulated experience and engineering skill gained over a period of many years. We particularly wish to emphasize that no attempt has been made to build machines cheap in first cost, instead special care has been given to dependability and final cost.

There are standard Williams machines for the reduction of practically every material, whether animal, mineral or vegetable—capacities range from 50 pounds to 300 tons per hour, permitting selection of exactly the proper size for your work. Whether you wish to grind chemicals to 400 mesh, crush 4 feet cubes of rock or shred steel turnings, you can profit by Williams' experience.

The Williams Patent Crusher & Pulverizer Co.

2706 North Ninth St. St. Louis, Mo.

Sales Agencies Include

Chicago, 37 W. Van Buren St. — New York, 15 Park Row — Oakland, Calif., 1629 Telegraph Ave.

OLDEST AND LARGEST BUILDERS OF HAMMERMILLS IN THE WORLD

Williams

PATENT CRUSHERS GRINDERS SHREDDERS

The CHLORONITROPARAFFINS

open the way to new chemical syntheses

This new Data Book on the Nitroparaffins and their Derivatives will gladly be sent on request.

Have you investigated this new group of Nitroparaffin derivatives? A study of their chemical structure and properties will undoubtedly suggest many uses and reactions well worth looking into.

Industrial fumigants, anti-gelling agents in rubber cements, starting points in synthesizing new organic chemicals—these are some of the uses that have been found in the short time the Chloronitroparaffins have been available. And it is more than probable that their most important applications are yet to be discovered.

Samples for laboratory investigation will be supplied upon request. We will be glad to work with you on any problems involving these compounds.

TABLE OF PROPERTIES

	1-Chloro-1-nitroethane	1-Chloro-1-nitropropane	2-Chloro-2-nitropropane	1, 1-Dichloro-1-nitroethane	1, 1-Dichloro-1-nitropropane
FORMULA	$CH_3CHClNO_2$	$CH_3CH_2CHClNO_2$	$CH_3CClCH_3NO_2$	$CH_3CCl_2NO_2$	$CH_3CH_2CCl_2NO_2$
Molecular Weight	109.52	123.54	123.54	143.97	157.99
Specific Gravity at 20°/20°C	1.258	1.209	1.193	1.405	1.314
Distillation Range, °C (90%)	122.0-128.5	139.5-143.3	129.0-132.3	122.0-125.0	141.0-143.6
Flash Point, °F (Tag open cup)	133	144	135	168	151
Refractive Index, at 20°C.	1.423	1.430	1.425	1.441	1.443
Solubility, at 20°C ml Solvent in 100 ml Water	<0.4	<0.8	<0.5	<0.5	<0.5

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A.I.Ch.E. to Meet in Boston

CHEM & MET NEWS OF MEETINGS & CONVENTIONS

CHEMICAL ENGINEERS HOLD SEMI-ANNUAL MEETING

THE SPRING semi-annual meeting of the American Institute of Chemical Engineers will be held May 11-13 in Boston, Mass.

Papers approved for presentation at the Monday technical session deal with such topics as New England chemical industries in the war, anhydrous hydrogen chloride gas, plastics from hydrolyzed lignocellulose and crude naphtha stabilizer performance.

Tuesday papers will deal with chemical engineering developments in grain distillery, dust control in the plastics industry, centrifugal fan design, compressed air for ammonia oxidation, pumps in the chemical industry, performance of rotary dryers, drip-point grid tower packings and many others.

Wednesday will be devoted to a joint symposium with the Heat Transfer Division of the American Society of Mechanical Engineers. W. H. McAdams will preside and nine papers will be presented.

DIVISION OF RUBBER CHEMISTRY POSTPONES MEETING

MEETING OF the Division of Rubber Chemistry, scheduled for April in Memphis, Tenn., in conjunction with the 103rd meeting of the American Chemical Society, has been cancelled by unanimous action of the executive committee. Thus reports H. I. Cramer, secretary of the division.

This decision was taken after a survey of the principal laboratories in the rubber industry disclosed the universal sentiment that the time and energy of all technical men within the industry should be directed toward problems of the present emergency.

A.I.Ch.E. STUDENT CHAPTER INAUGURATED AT TUFTS

THE AMERICAN Institute of Chemical Engineers inaugurated its 79th student chapter at Tufts College, Medford, Mass., on March 17. Ceremonies were held at the Engineers' Club, Boston, with about 70 of the new members present. A banquet at which Dean Harry P. Burden was toastmaster preceded the inaugural.

Speakers included John P. Blake, director of research of the Simplex Wire & Cable Co.; Gustavus J. Esselen, vice-chairman of the Massachusetts Board of Professional Engineers; Sidney D. Kirkpatrick, president of the American Institute of Chemical Engineers and editor of *Chem. & Met.;* Kenneth Bell, chairman of the Boston Section of the Institute; and Dr. Leonard Carmichael, president of Tufts College and head of the National Roster of Scientific Personnel. Dr. Carmichael stated that findings of the Roster indicate that chemical engineers will be required to an even larger degree for the post-war reconstruction period than at present.

CANADIAN CHEMICAL CONVENTION TO BE HELD IN JUNE

AT THE DECEMBER meeting of the Council of the Canadian Chemical Association, it was decided to accept the invitation of the Hamilton Chemical Association to hold the 25th annual Canadian Chemical Convention at Hamilton, June 1-2. In view of the present conditions, it was announced that the program would be devoted entirely to business.

AMERICAN CHEMICAL SOCIETY MEETS IN MEMPHIS

THE 103RD MEETING of the American Chemical Society will be held in Memphis, Tenn., April 20-24. Technical sessions will be held by 17 of the society's 18 professional divisions and more than 3,000 chemists are expected to attend the convention. It will deal with chemical development in the South and in the Memphis area, and symposia will be devoted to progress in medical chemistry, vitamins, nutrition, agriculture and other fields.

W. F. Bowld, general manager of the Buckeye Cotton Oil Co., Memphis, has been appointed general chairman of the convention committee. The honorary chairman is Dr. Victor A. Coulter of the University of Mississippi. Registration will begin April 19 in the Memphis Municipal Auditorium.

AMERICAN PETROLEUM INSTITUTE CANCELS MID-YEAR MEETING

THE 12TH MID-YEAR meeting of the American Petroleum Institute, scheduled for May 25-28 in Oklahoma City, Okla., has been cancelled, reports R. R. Boyd, Jr., president of the Institute.

This action was taken by the Institute's executive committee upon Mr. Boyd's recommendation, since so many of the members of the Institute and of its working committees are actively engaged in the war effort.

ELECTROCHEMISTS ELECT OFFICERS

THE ELECTROCHEMICAL Society, holding its 81st convention April 15-18 at Nashville, Tenn., elected the following officers for the coming year: president, E. M. Baker, department of chemical engineering, University of Michigan; vice presidents, R. V. Mears, research department, Aluminum Co. of America; J. A. Lee, managing editor, *Chem.&Met;* and C. L. Mantell, consulting chemical engineer, New York. Re-elected were Colin G. Fink, Columbia University, as secretary and R. M. Burns, Bell Telephone Laboratories, as treasurer.

New members of the Board include G. B. Hogaboon, recently affiliated with the W.P.B.; C. L. Faust, Battelle Memorial Institute; and L. B. Hitchcock, Hooker Electrochemical Co.

The $1,000 Weston Fellowship Award to the most deserving young student was presented to William E. Roake, graduate student of Oregon State College. The Young Author's Prize for the best electrochemical paper published during the past year was given to Dr. Edward Adler, department of chemistry, College of the City of New York.

CALENDAR

APRIL 19-24	American Ceramic Society, annual meeting, Hotel Netherland Plaza, Cincinnati, Ohio.
APRIL 20-24	American Chemical Society, semi-annual meeting, Municipal Auditorium, Memphis, Tenn.
MAY 3-5	The Society of Plastics Industry, annual meeting, The Homestead, Hot Springs, Va.
MAY 11-13	American Institute of Chemical Engineers, semi-annual meeting, Boston, Mass.
JUNE 22-26	American Society for Testing Materials, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

A GOOD

The valve illustrated—Fig. 2559—is a flanged end Swing Check Valve, with bolted cap. Available in sizes from 2" to 16". May be obtained in any one of various alloys for corrosion service and to meet special requirements of the chemical and process industries. Can also be furnished with screwed ends in sizes 2" to 6".

POWELL

NAME

You don't build a good name in a day or a year. It comes from doing a good job for a long time. After that, people begin to expect a good job from you and they bring their business to you for that reason.

We've been at our job a long time. Just four years short of a century. All these years we've been making valves. With each new industrial development in which valve design has played a part we've made new valves or adapted existing models to changing needs. In each instance our efforts have met with the approval of the Industry which was served.

This experience has taught us to expect changes and to be prepared for them. It has led us to build up a well trained engineering and research department fully equipped to handle new valve problems as they arise in the Progressive march of American Industry.

The Powell Line itself is evidence that we have not been idle. The ever-increasing demand for Powell stock valves and Powell engineering service is a constant reminder that the job we have been doing all this time has satisfied our clients, and has given them reason to expect that it will continue to be good. This is, in our conception, the meaning of a good name.

THE WM. POWELL CO., Cincinnati, Ohio

VALVES

THE Right Answer TO
YOUR DUST CONTROL PROBLEM

COMPARE the "Dustube" point-by-point and you will see how well it meets your dust control needs.

It is *Simple:* The cloth tubes can be quickly installed, inspected or removed; they are light and economical to ship and store; they prevent bridging and clogging; being amply spaced they decrease resistance to air flow, therefore, there is a saving in power and the air velocity throughout the collector is kept uniform; the tubes clean more rapidly and thoroughly because they are shaken like a rug while limp and deflated.

It is *Economical:* Operating and maintenance costs are confined to power for operating the fan and shaker and the occasional replacement of an inexpensive cloth tube.

It is *Efficient:* Performance records show that its efficiency by weight is 98% and more; by dust count the discharged air shows less than ten million particles per cubic foot from two to ten microns in size.

AMERICAN
FOUNDRY EQUIPMENT CO.
347 S. BYRKIT ST.
MISHAWAKA, IND.

WELDING SOCIETY ANNOUNCES DECISION TO HOLD MEETING

THE AMERICAN Welding Society will hold its annual meeting this year as usual, it was recently announced by Col. Glen F. Jenks, president of the Society. This will be the Society's twenty-third annual meeting.

In making the announcement, officials of the Society expressed their belief that the best interests of the war effort would be served by intensifying their Education Engineering Program. It was pointed out that a total of 47 fundamental research projects are now being conducted by the Society, and that many of its 21 standing technical committees have assisted the war effort by making their latest findings available for war production. The Committee on Minimum Requirements of Instructions for Welding Operators in Trade Schools has aided establishment of training for vitally-needed welding operators in 350 defense training classes and licensed welding schools throughout the country.

INSTITUTE OF FOOD TECHNOLOGISTS TO MEET IN JUNE

FACED WITH heavy war-time demands upon existing supplies of strategic metals, ingredient commodities and packaging materials, members of the Institute of Food Technologists have adopted "Conserve for Victory" as the theme of their third annual meeting, to be held at the Hotel Nicollet, Minneapolis, Minn., June 14-17.

Papers and sessions will be devoted to such topics as "Food Technology in War," "Recent Developments in Food Technology," "War Problems in Food Stock Pile Storage," "Substitute Materials for Food Processing," "Dehydration of Foods," "Packaging and Materials," "Industrial Sabotage," and "Labor Relations."

The Institute of Food Technologists, organized in 1939, now has a membership consisting of more than 1,200 chemists, bacteriologists, process engineers and others similarly trained or experienced in the manufacture, preservation, and handling of foods.

SELECTIONS FROM CONVENTION PAPERS

FACTORS INFLUENCING THE PERFORMANCE OF ROTARY DRYERS

ON THE BASIS OF a large number of experimental tests, the following empirical equation has been suggested for estimating the time of passage or retention time for rotary dryers:

$$T = \frac{k\,L}{RDS} + m\,V$$

In the above equation T is retention time in minutes; L is length of dryer in feet; R is revolutions per minute; D is diameter of the cylinder in feet; S is the slope of the cylinder in in. per ft.; V is air velocity in ft. per minute; k and m are constants. The constant k is characteristic of the dryer design, being dependent upon the number of flights and their design. For the flights investigated, k was found to vary from the value of 3.3 for six flights to 4.5 for twelve flights.

The constant m is dependent upon two factors, the first being the character of the material being dried, that is the ratio of screen size to particle density, and the second the method of operating the dryer. The constant m is the slope of the retention time-air velocity curve and is positive for counter-current flow and negative for parallel current flow. Over the range of the materials studied, m was found to vary from 0.015-0.045 for parallel flow and from 0.02-0.08 for counter-current flow.

In order to predict the retention time of commercial dryers, the following procedure was suggested: With the small experimental dryer set at the proper slope and speed, the time of passage of the charge from which the constant k may be calculated is found by using optimum loading and zero air velocity. The test is then repeated using a known air velocity, and m obtained as the slope of the retention time-air velocity curve. These constants are then substituted in the equation and applied to the desired problem.

C. F. Prutton, C. O. Miller and W. H. Schuette, Case School of Applied Science, Cleveland, Ohio, and Dow Chemical Co., Midland, Mich., respectively, before the American Institute of Chemical Engineers, Virginia Beach, Va., November 3-5, 1941.

PROTECTION FROM BLISTER WARFARE GASES

MOST EFFECTIVE of the warfare gases used in World War I were mustard gas and Lewisite, both classified as vesicants or blistering agents. Many observers believe that if a gas attack is launched by the Axis powers against a civilian group, the gas most likely to be used is one of these vesicants. Mustard gas is considered a favorite for use on cities, manufacturing areas, and other civilian groups because it is highly effective and very persistent. The effectiveness of mustard gas in World War I as an agent for producing injuries is indicated by the fact that only 60 lb. of mustard gas were required per casualty as compared to 500 lb. of high explosive per casualty. Approximately 30 percent of the non-fatal casualties of that war were caused by the various chemical gases and about 25 percent by mustard gas alone.

Resistance of clothing to penetration by the blistering agents can be summarized as follows:

Materials	Protection from: Vapor	Liquid
Cotton, wool, silk, rayon..	slight	none
Leather, rubber.....	fair	slight
Oilskin, heavy rubber, impregnated leather....	good	fair to good

Protection from the vesicants can be

We Can Save Money
for Users of
DISTILLED WATER
by chemical treatment
WITHOUT HEAT!

OPERATION — In operation, water passes through two beds of special minerals, the first of which removes, by base exchange, the positive ions, such as calcium, magnesium, sodium, or iron, substituting hydrogen. The hydrogen combines with the negative sulphate, chloride, and nitrate ions to form the equivalent acids. (The carbonates form carbonic acid which passes on through as CO_2 and water, and the CO_2 can be very largely dispelled by aeration if its presence is undesirable.) This acidic water passes to a second tank where the negative ions (chlorides, sulphates, and nitrates) are removed by adsorption, giving a final effluent which compares very favorably with single distilled water.

1,000 gallons for less than a dollar!

Water produced by the Illco-Way method replaces distillation at *a fraction of the cost* . . . and meets the exacting standards of pharmaceutical houses, chemical plants, distilleries, mirror and battery manfacturers, porcelain enamelling plants and other industrial concerns requiring purified water.

Completely automatic (between periodic regenerations) — water is not evaporated, so no heat is required — pipes will not lime up — minimum maintenance cost. A unit delivering 300 gallons an hour occupies space about 4 x 10 feet. Made of finest material to protect purity of water. Available in units affording from 150 gallons an hour to 15,000 galions an hour.

WRITE FOR FULL FACTS. *Get complete details of operation and examples of remarkable savings. Write today.*

TESTED IN THE LABORATORY
ILLCO-WAY
PROVED IN THE FIELD

ILLINOIS WATER TREATMENT CO.
844 Cedar St., Rockford, Illinois

We even lick STAMPS

OF all the many conveniences that we take for granted the ordinary postage stamp ranks high. Yet without gummed backs postage stamps would be a first class nuisance. Transfer of this special gum at the U. S. Bureau of Engraving and Printing is but one of innumerable industrial, process and chemical functions performed by Quimby Pumps with dependability and economy.

The many unusual applications of Quimby Pumps are vitally important in themselves but of even greater significance is the virtually unlimited range of application that they illustrate. Pumps are relatively small compared with other plant equipment. However, their trouble-free performance is far out of proportion to their size. Whether your problem of liquid transfer is large or small you will find a parallel to it in Quimby's half century of experience.

THE BEST PUMP FOR THE JOB
IS THE MOST ECONOMICAL PUMP TO USE

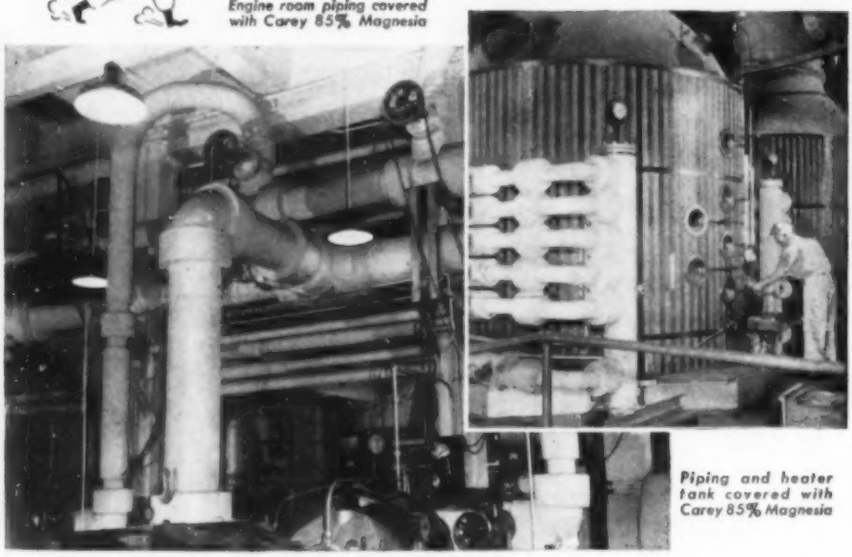
QUIMBY PUMP COMPANY, INC.
351 Thomas St., Newark, N. J.

QUIMBY PUMPS

Better Pumping Practice
SINCE 1894

Carey HEAT INSULATIONS

HELPING PRODUCE SWEETS ECONOMICALLY for America at War!



Engine room piping covered with Carey 85% Magnesia

Piping and heater tank covered with Carey 85% Magnesia

The American Molasses Company, Brooklyn, N. Y., manufacturer of molasses and syrups of many kinds, is doing its bit to meet the nation's urgent "sweets" requirements. Their Grandma's Molasses is rich in nature's iron—needed in the daily diet to help build buoyant health, the goal of the National Nutrition Program. In processing the raw materials brought by boat from the West Indies and other sources, CAREY INSULATIONS are performing an essential service.

Because of the exposed location of the company's plant, correct insulation of the long, low-pressure steam lines going to the processing machines, is necessary to prevent excessive heat losses. These lines, together with the high pressure steam piping, are insulated with CAREY 85% Magnesia. Referring to this insulation, Mr. John Dobson, the Company's chief engineer, says: "No repairs whatsoever have been necessary on the Carey Insulation during the six-year period it has been in use; it looks good for another 20 years."

When you buy insulations, look for permanence as well as efficiency. CAREY insulations provide BOTH in outstanding measure, as demonstrated in many of the nation's leading industrial and power plants. Whatever your insulation needs, you're SAFE with CAREY. A national organization is at your service. For details address Dept. No. 15.

The PHILIP CAREY Manufacturing Co.

Dependable Products Since 1873

Lockland, Cincinnati, Ohio

IN CANADA: THE PHILIP CAREY COMPANY, LTD. Office and Factory: LENNOXVILLE, P. Q.

obtained by: (1) immediate evacuation from within or adjacent to the contaminated area: (2) central bombproof and gasproof public shelters, although no apparent justification for such shelters exist at this time, as the labor, money and materials needed can better be used in waging an offensive war; (3) specially designed protective clothing; (4) remaining in the home.

An ordinary well-constructed building with the doors, windows or other openings sealed to eliminate drafts will offer a high degree of protection for a good many hours. Remaining in the home and engaging in as little activity as possible is a fairly secure means of individual and family protection. Many protective ointments and salves have been tried and found to be ineffective against blister gases.

George L. McCoy, chemical engineer, before The Junto, Philadelphia's Adult School, 16 South 10th St., Philadelphia, Pa., March 13, 1942.

• • •

When one part of ground serpentine is mixed with three parts of newly made superphosphate, a chemical reaction takes place and a serpentine superphosphate is obtained. This product is now replacing in part the ordinary type of superphosphate in New Zealand. It contains the magnesium and silica of the original serpentine, but these are in more active form than in the original rock. The phosphate content is less soluble than that in ordinary superphosphate, but is still available to plants. The product not only supplies both magnesium and phosphate to the soil, but a number of trace elements as well.

• • •

FLOTATION TREATMENT OF WHITE WATER

AN INVESTIGATION of the behavior of pure fatty acid soaps ranging from 6-18 carbon atoms and natural fat soaps was made with equipment designed to duplicate the details of treatment in a commercial flotation save-all. White waters, containing both clay and clay-fiber mixtures, were aerated, exposed to the atmosphere for 15 seconds and submitted to 7 inches of mercury vacuum. The water clarity was measured by the use of a photoelectric cell. In all comparisons, aluminum sulphate was used as a precipitant.

Efficiency of flotation, or the water clarity after 5 minutes, with pure fatty acid soaps increased with the length of the acid carbon chain up to and including myristic with 14 carbon atoms. Above this the soaps became less effective.

An increase in the proportion of fiber in the white water resulted in consistent improvement in flotation. Some soaps exhibited marked changes in efficiency at the extreme, that is 100 percent fiber and 100 percent clay, while other showed comparatively slight differences.

Flotation improved with the alum concentration up to an optimum point,

depending on the soap present. Increased alum resulted in a lowering of efficiency. With the use of natural fat soaps, such as cottonseed, linseed, soya, corn and peanut, flotation efficiency tended to increase to the extent of unsaturation or iodine number. Many inconsistencies were noted, most of which could be explained by the fact that such mixtures of fatty acids were decidedly inferior to the constituent acids when used individually.

Behavior of the pure fatty acid soaps, the superiority of an intermediate chain-link acid, and the effect of alum concentration were explained by the varying solubility of the aluminum soaps formed.

E. N. Poor, W. C. Hamilton & Sons, Miguon, Pa., and H. A. Whitenight, before the Technical Association of the Pulp and Paper Industry, New York, N. Y., February 16–19, 1942.

• • •

It is reported that the Germans have found that a 2 percent addition of cerium has a remarkable effect on the fluidity of cast iron, also acts as a desulphurizer and increases the tensile strength. Cerium is produced almost altogether from Monazite sand.

• • •

OLIVINE AS A SOURCE OF MAGNESIUM

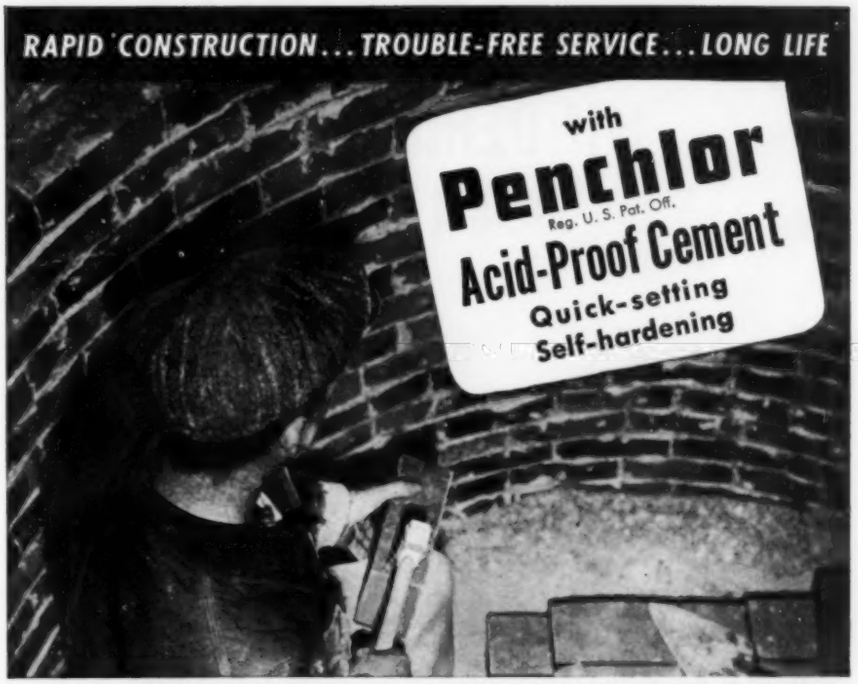
OLIVINE IS considered as a potential source of raw material for metallic magnesium in the electrolytic chloride process. Treatment of olivine, which has the formula $(Mg.Fe)_2SiO_4$, with hydrochloric acid must be carried out under conditions which prevent the formation of gelatinous silicic acid. This is avoided by the dehydrating action of $MgCl_2$, which takes up water to form a series of hydrates and leaves silicic acid in a granular condition. Leaching separates $MgCl_2$ from the silicic acid and unattacked ore. The leach solution can be purified by the addition of caustic magnesia and the precipitated impurities removed by filtration. Direct chlorination of olivine has two major defects: (1) a large part of the Cl_2 goes to form silicon and iron chlorides; (2) anhydrous $MgCl_2$ is held by absorption in the finely divided SiO_2.

With the exception of brucite and high-grade magnesite, olivine contains more magnesium than any other mineral, ranging from 27-30 percent Mg. It has been estimated that the ore can be mined and crushed to aggregate sizes for approximately $1.50 per ton. Calcium, entirely absent from many samples, seldom exceeds 0.1 percent.

Semi-plant scale work now being done at the State Engineering Experiment Station, Georgia School of Technology, has shown that olivine and hydrochloric acid react according to the following equation:

$$Mg_2SiO_4 + 4\ HCl = 2\ MgCl_2 + H_2SiO_3 + H_2O$$

Magnesium chloride may take up water from the reaction to form one or more hydrates up to the hexahydrate. It is evident that $MgCl_2$ may



PENCHLOR ACID-PROOF CEMENT is used to make the mortar with which these acid-proof bricks are being laid in lining a tank to store hot dilute sulphuric acid at the chemical by-products plant of the Chesapeake-Camp Corp., Franklin, Va. Construction Contractors: A. Lynn Thomas Co., Inc., Richmond, Va.

Here is another installation where *Penchlor Acid-Proof Cement* will prove its worth in years of dependable service. This quick-setting sodium silicate cement was chosen because of its proven record of highly satisfactory service under severe acid conditions . . . a record that includes successful application in most of the important chemical plants throughout the United States, in steel mills, in paper and pulp mills, oil refineries and smelting plants.

With time a vital factor in new construction, the quick-setting and self-hardening qualities of Penchlor Acid-Proof Cement are a greater advantage than ever. There need be no delays in putting brick-lined equipment into service.

If your conditions require a corrosion-proof cement with unusual strength and exceptional resistance to abrasion, use one of our resin cements, such as *Asplit* for conditions which are always acid—or *Causplit* for conditions alternately acid and alkaline. You will find these easy to handle and capable of withstanding a wide range of corrosive conditions at temperatures up to 350 degrees F.

Long experience in our own chemical plants in handling acids and alkalis makes it possible for us to put seasoned engineering service at your disposal—without obligation, of course. Write us fully. Or if you prefer, use the coupon below.

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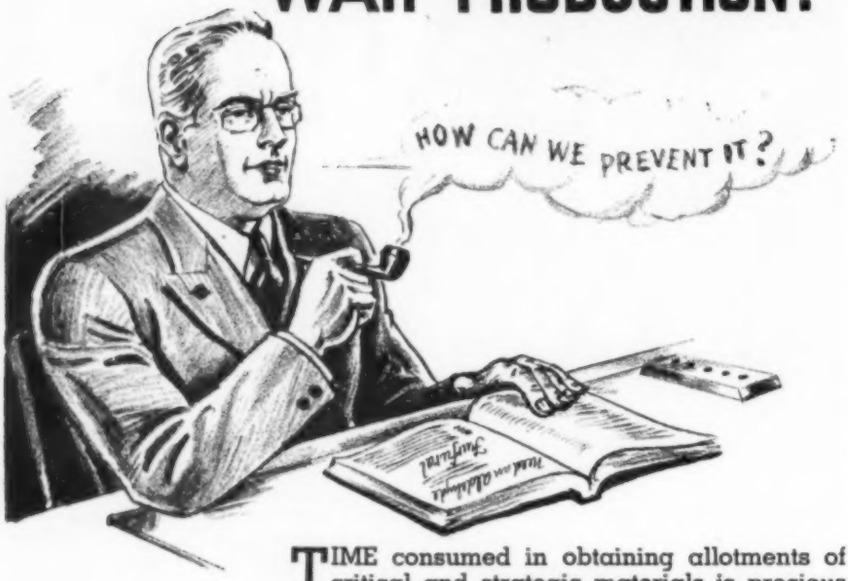
ARE MATERIAL SHORTAGES HINDERING YOUR WAR PRODUCTION?



TIME consumed in obtaining allotments of critical and strategic materials is precious time lost in the Nation's production effort. Your patriotic duty is to bend every resource to ease the strain on those strategic materials. So it is time to get acquainted with—

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The Furans

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FURFURYL ALCOHOL

TETRAHYDROFURFURYL ALCOHOL

HYDROFURAMIDE

Here is a *plentifully available* aldehyde made in the center of the Nation from domestic raw materials. In many cases it proves to be more than a mere substitute. For example, enterprising resin manufacturers find that in phenolic resins, Furfural makes a pound of phenol go further.

Typical properties of this compound include:

Boiling point	157—67° C.
Specific gravity	1.161 (20/20)
Freezing point	—37° C.
Flash point (open cup)	56° C.
Color	Straw yellow to amber

It is miscible with most organic solvents except petroleum hydrocarbons and glycerol. Water solubility at 20°C. is 8.3%. It disperses cellulosic derivatives such as nitrocellulose and cellulose acetate.

Properly handled Furfural is amazingly stable. To many individuals it comes as a surprise that in at least one field of application it is heated repeatedly to temperatures of 400°F. and above without decomposition of consequence.

As a selective solvent, resin ingredient, preservative, general solvent, light sensitive agent, adhesion improver, wetting agent, stain, and resin dispersent you must not overlook Furfural.

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TECHNICAL DIVISION 5-3 **CHICAGO, ILLINOIS**

FURFURAL - FURFURYL ALCOHOL - HYDROFURAMIDE
... TETRAHYDROFURFURYL ALCOHOL ...

combine with all the water formed, plus a considerable part added as HCl solution. If the water is kept at a minimum by using strong acid, practically all of it will be taken up by the $MgCl_2$, leaving the silicic acid in granular condition in which form it can be readily removed. If excess water is used, the silicic acid will go to the gel form, which is not only troublesome to separate but also forms a film on the olivine and inhibits further attack.

A convenient method of treatment which prevents formation of gelatinous silicic acid consists in treating crushed olivine with sufficient strong acid to wet the particles. The reaction is rapid and considerable heat is evolved which promotes complete consumption of the acid and also dehydration of the mixture.

If the resulting mixture is leached with water, a strong leach can be obtained and this removes practically all the $MgCl_2$. It is possible to add fresh acid and repeat the treatment until the ore is completely consumed. The silicic acid accumulates as a crust on the ore particles, but does not inhibit further reaction with acid. If desired, the crust can be scrubbed from the unreacted ore by treatment in a rake classifier or similar equipment.

Magnesia and magnesium hydroxide are equally effective as purifying agents. Removal of free acid and nickel is complete and only a trace of iron remains. Although half of the iron is usually present in the ferrous condition, its oxidation has not been found necessary. Precipitated impurities settle readily and can be removed from the solution by decantation or filtration.

Although results of the work indicate that olivine can be converted at low cost to $MgCl_2$ of suitable purity for electrolytic cell feed, it is impossible to make a sound evaluation of the process as a whole until completion of pilot plant work.

E. C. Houston, associate chemist, and H. F. Rankin, chief of the minerals section, Regional Products Research Division, Commerce Department, Tennessee Valley Authority, Knoxville, Tenn., before a joint meeting of the Industrial Minerals Division, American Institute of Mining and Metallurgical Engineers and the American Ceramics Society, Rolla, Mo. October 23–24, 1941.

HIGH EFFICIENCY CYANIDE COPPER BATH

THE HIGH EFFICIENCY cyanide copper process was introduced in 1938 by the du Pont Company under the name "High Speed Copper" to provide a method for the rapid application of smooth, bright, heavy deposits from cyanide baths.

Before the introduction of the high efficiency cyanide process, the Rochelle salt bath was probably the most satisfactory copper bath for applying smooth, fine-grain copper deposits prior to bright nickel plating. Plain cyanide copper baths have also been used extensively for conventional electroplating purposes.

Recognized deficiencies of the Rochelle

and other dilute type cyanide baths are: (1) variations in anode and cathode efficiencies (30-70 percent) make solution control difficult, promote cyanide decomposition and result in objectionable gassing; (2) limited cathode current densities together with low cathode current efficiencies necessitate unreasonably long plating time for production of heavy deposits in modern plating cycles. These deficiencies are largely overcome by the high efficiency cyanide copper process, which provides anode and cathode efficiencies of approximately 100 percent. However, in common with other bright plating processes, the high efficiency cyanide process employs brightening and anti-pit agents and requires close adherence to established operating conditions with respect to bath composition and temperature.

The high efficiency bath differs greatly from prior art baths in that it produces smooth, bright deposits up to 0.002 in. in thickness. The bath formula for the high efficiency cyanide process is as follows:

Agent	Preferred Composition[1]	Approximate Limits[1]
Copper cyanide	16	12-20
Sodium cyanide	18	13.5-22.5
Free NaCN corresponding to NaOH	4	3-5
Corresponding to KOH	5.6	4.2-7
Brightener	2	1.5-2.5
Anti-pit agent	0.2	0.15-0.25

[1]As oz. per gal.

Cathode current density under preferred operating conditions is from 10-100 amp. per sq.ft. while anode current density is from 5-30 amp. per sq.ft. The E.M.F. on still tanks is from 1-2.5 volts at bus bars and on barrel units is from 3-4 volts. The rate of copper deposition at 8.8 amp. per sq.ft. is 0.001 in. per hr. Both cathode and anode efficiencies are approximately 100 percent at a temperature of 75-85 deg. C. Cathode bar agitation is 2-15 ft. per min.

H. L. Benner and C. J. Wernlund, Electroplating Division, E. I. du Pont de Nemours & Co., Niagara Falls, N. Y., before the Electrochemical Society, Chicago, Ill., October 3, 1941.

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Phthalonitrile, a new insecticide appearing to act as either a stomach or a contact poison, has been shown to be generally superior to lead arsenate and derris against certain leaf-eating insects. It is also effective as a soil insecticide for termites.

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GUAYULE AS A SOURCE OF RUBBER

GUAYULE IS A rubber-producing, desert shrub native to North Central Mexico and the Big Bend area of Texas. In 1912, the year of greatest output, Mexico produced 10,000 long tons of guayule rubber, but production declined to about 4,000 tons in 1940. Output may amount to 7,000 tons in 1942.

For the past 30 years, the Intercontinental Rubber Co. has cultivated guayule at its experiment station near Salinas, Calif., where about 1,000 acres are under cultivation. From this about 225 long tons of rubber were produced

Does BECKMAN pH CONTROL Pay?

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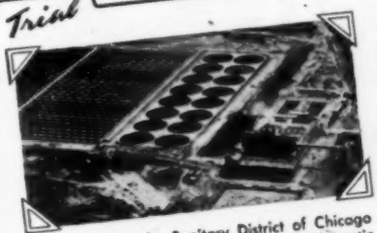
Today minutes are priceless . . . *and so are materials!*

So anything that will speed up production . . . anything that will save time in process operations . . . anything that will reduce waste and increase output, merits your immediate investigation. Beckman pH Control is doing these things—NOW . . . in thousands of different fields, ranging from electroplating aircraft parts to refining sugar . . . from speeding up chemical processes to reducing costs of waste disposal.

Trial



Sometime ago the Sanitary District of Chicago made a trial installation of Beckman Automatic pH Control in their large Stickney Plant. Months of rigid testing proved, conclusively, that Beckman pH Control makes important savings in chemicals, increases plant efficiency, reduces waste, saves time!

Repeat

So profitable was the initial Beckman installation, that the Sanitary District ordered a second Beckman Automatic pH installation for its Calumet Plant to control pH of the treating operations there.

Repeat

And now the District has ordered a THIRD Beckman Automatic pH installation for still another location in its large municipal system. There's no mistaking conclusive evidence like that!

And it is doing its job so well that one installation leads to another. For example, the Sanitary District of Chicago tried Beckman Automatic pH Control on the chemical end of its sewage-treating operations . . . found it saved not only time and chemicals, but increased plant efficiency and decreased operating costs so successfully that a *second* installation was ordered for another plant . . . and now a THIRD installation has been ordered for still another location. *Clear-cut evidence like that tells its own story!*

WHAT ABOUT *Your* PLANT?

Do you use water or water solutions *anywhere* in your plant? . . . in chemical or electro-chemical processes? . . . in boiler feed? . . . in waste disposal? . . . *anywhere*? Then investigate NOW what Beckman pH Control can do toward helping you do your job better — faster — with less waste! Our research staff will gladly study your problem and can perhaps suggest how others in your field are now using Beckman pH Control to cut costs . . . *save time!*

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WORLD'S LARGEST MANUFACTURER OF GLASS ELECTRODE pH EQUIPMENT

Beckman THE LEADING NAME IN pH

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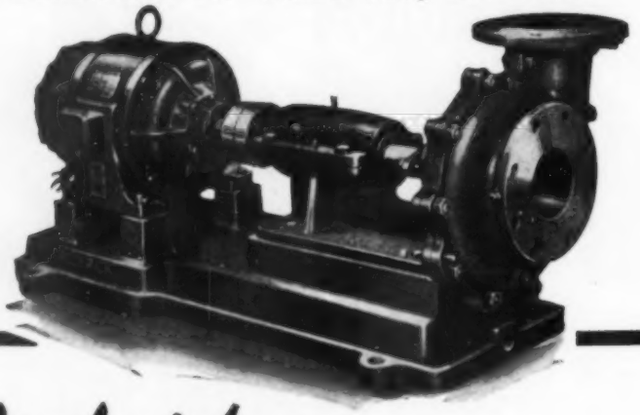

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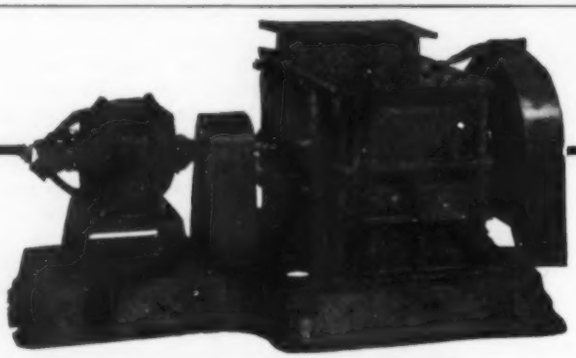

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AMERICAN PULVERIZER CO. 1219 MACKLIND AVE. ST. LOUIS, MO.

The Office of the Petroleum Coordinator proposes to multiply the petroleum industry's capacity to manufacture high-octane gasoline for warplanes to as much as 200,000 bbl. per day. Peak production of this type of gasoline during 1941 was 45,000-50,000 bbl. per day.

• • •

in 1940. This concern has selected high-yielding, disease-resistant strains of guayule and has devised special machinery for planting, cultivating and harvesting the shrub.

Guayule may be harvested at any time between the ages of one and 30 years, the general practice being to harvest it at four years. The rubber content increases up to about ten years, after which the shrub becomes gnarled and there is little or no further increase in rubber content. The entire shrub is taken from the ground and the rubber is removed mechanically from the root, stem and large branches.

Cost of producing guayule rubber depends upon the age at which the plant is harvested. Starting with a cost of about 80 cents per lb. of rubber when the plant is harvested at one year, the cost decreases for every year until it is seven years of age. When the plant is harvested after four years, rubber can be produced at a cost of 15-19 cents per lb., including all costs incidental to producing the rubber except interest on investment and cost of de-resinating.

Guayule rubber has a resin content of about 20 percent and unless it is de-resinated is suitable only for blending with Hevea rubber or for friction stocks. It is especially suited for use in rubberizing tire fabric plies. Tires made from unde-resinated guayule rubber give a mileage about 60 percent as great as tires made from Hevea ribbed smoked sheet No. 1. However, when guayule rubber is de-resinated, it is of the same quality as the lower grades of Hevea rubber and can be used interchangeably with them.

If substantial quantities of guayule rubber were de-resinated, the cost of de-resinating would not exceed 1-2 cents per lb. Information available indicates that capital investment for agricultural equipment, buildings, rubber extraction mills, de-resinating factories, etc., probably would amount to about $20,000,000 per 100,000 long tons of yearly production capacity.

If all guayule seeds available were planted there would be only enough seedlings to plant 45,000 acres in the spring of 1942. If such an acreage were harvested in 1943, it would yield a total of about 1,500 long tons of de-resinated rubber. If the 45,000 acres were not harvested until 1944, they would yield approximately 5,400 long tons, and if harvested in 1946, about 21,300 long tons.

In 1943 there could be made available sufficient seedlings to plant 450,000 acres. This might yield 15,000 long tons if harvested in 1944; 54,000 long tons if harvested in 1945; or 213,000 long tons if harvested in 1947. There

could be made available in 1944 sufficient seedlings to plant 4,500,000 acres. Theoretically, this acreage might yield 150,000 tons if harvested in 1945 or 540,000 tons if harvested in 1946.

"Possibilities of Producing Rubber in the United States and Rubber Conservation," U. S. Tariff Commission, Washington, D. C., September 1941.

• • •

The "Cronak" process consists of degreasing and cleaning galvanized sheet or products, then dipping in diluted hydrochloric acid, followed by a dip in a dichromate solution, rinsing, and rapid drying at low temperature. The treatment, which produces a bronze tint on the surface, is declared to provide protection for the underlying metal, particularly from corrosion by stagnant water.

• • •

PRACTICAL METHODS FOR STORING VOLATILE LIQUIDS

IN SELECTING the class of storage best suited to a particular set of conditions, the engineer has recourse to five basic types of tanks or containers. These are: (1) atmospheric tanks with fixed roofs; (2) tanks with variable volume vapor spaces; (3) floating roof tanks; (4) pressure tanks; (5) underground storage tanks. All of these are containers constructed of steel plates using either riveted or welded construction.

Cost of storing any volatile liquid is made up of the following items; (1) initial cost of storage tanks amortized in some specified period of time; (2) interest on the investment in tankage; (3) cost of maintenance; (4) cost of product lost by evaporation. Suppose it is desired to know what type of 80,000 bbl. tank and roof will provide the lowest cost storage for the operating conditions listed below:

Product stored	10 lb. *RVP* motor gasoline
Value of product	6 cents per gal.
Size of container	80,000 bbl.
Annual throughput	480,000 bbl. (6 fillings)
Average outage	20 ft.
Cost of containers	See table
Amortisation period	10 years
Rate of interest	4 percent
Evaporation losses	Values obtained from charts for an average tank temperature of 60 deg. F.

Costs of storing the gasoline under these conditions in tanks equipped with a cone, breather, balloon, or pontoon roof are analyzed in the accompanying table. It will be noted that the most economical storage is provided by the tank equipped with a floating roof.

Type of Roof and Tank	Cone	Breather	Balloon	Pontoon
Erected cost of tank*	$34,000	$37,000	$41,000	$41,000
Annual breathing evap. loss, gal	70,000	19,000	.....	6,000
Annual filling evap. loss, gal	32,000	32,000	32,000	.....
Annual total evap. loss, gal	102,000	51,000	32,000	6,000
Cost of tank per year	$3,400	$3,700	$4,100	$4,100
Average yearly interest at 4 percent	680	740	820	820
Annual maintenance cost	100	100	100	250
Cost of evaporation loss at 6 cents per gal	6,120	3,060	1,920	360
Total yearly storage cost	$10,300	$7,600	$6,940	$5,530
Annual storage cost in cents per bbl	12.9	9.5	8.7	6.9

*Based on welded storage tanks.

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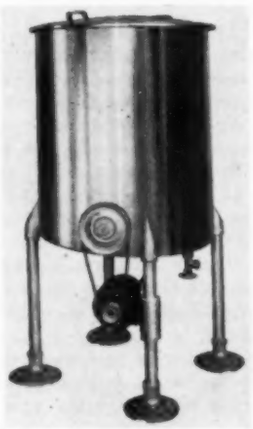

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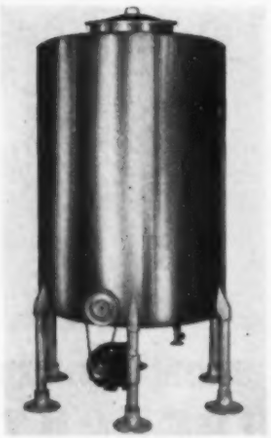

30 Gal. to 2000 Gal. 100 Gal. to 2000 Gal.

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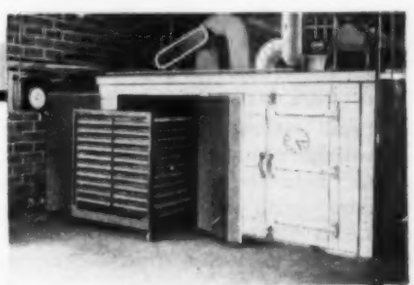

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SUPERCUTNO Self-Lubricated Packing makes a hit with plant engineers and maintenance men because it saves them repacking time, labor and expense.

Pumps, valves, and other acid-handling equipment give longer, more trouble-free service when packed with SUPERCUTNO, because its abundant acid-proof lubricant protects shafts, rods and stems from scoring.

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In regions where the distance from possible enemy air bases makes above-ground storage relatively safe, the use of tanks equipped with floating roofs is recommended as the best practical protection against sabotage. It would be possible for a saboteur to start a fire in the space between the rim of the roof and the tank shell, but such fires can be extinguished with comparative ease before any serious damage has been done.

Atmospheric tanks with fixed roofs equipped with conservation vent valves are suitable for products of low volatility such as fuel oil, kerosene and heavy crude oil.

Tanks with roofs which provide a variable volume vapor space are used most advantageously in these ways: (1) breather roofs provide economical storage for light products such as motor gasoline or light crude oils in tanks which normally remain full or nearly full; (2) balloon roofs which have a relatively large volume afford the lowest cost storage for motor gasoline and similar products in slow working tanks which are filled and then emptied gradually over a period of several months.

Floating roofs provide the most economical means for storing motor gasolines, light crude oils and other products of similar volatility in active tanks which are worked either continuously or intermittently. Floating roofs are also recommended for installations in which reduction of fire hazards is one of the prime considerations in selecting the type of tank.

Pressure tanks such as spheres and spheroids afford the only practical method for storing natural gasoline, iso-pentane, butane and other light products which would suffer enormous losses from boiling in ordinary storage tanks.

D. E. Larson, development engineer, Chicago Bridge & Iron Co., Chicago, Ill., before the American Institute of Chemical Engineers, Virginia Beach, Va., November 3-5, 1941.

• • •

Bismuth makes 18-8 stainless steel machinable without impairing corrosion resistance. The effect of this addition (0.5 percent bismuth) is said to be so remarkable that it is predicted that it will quickly replace the selenium which has been regarded as the best addition for making 18-8 machinable.

• • •

SELENIUM AND TELLURIUM IN INDUSTRY

NEARLY 1,000,000 lb. of selenium is recovered yearly in peace-time and an additional half-million pounds can be recovered with no additions to existing plants. World production of tellurium is probably about 200,000 lb. yearly. Availability of selenium and tellurium is the result of their being present in small amounts in sulphides of copper, silver and gold. The removal of selenium and tellurium is necessary during the processing of these ores.

Selenium was one of the first substances found to have properties which

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are sensitive to light and the selenium photocell, when connected to a deflecting galvanometer, comprises the ordinary photographic exposure-meter. Construction of selenium rectifiers is similar to that of photocells. Such rectifiers have many electrical applications, their use in battery charging being one of the most familiar.

About 100,000 lb. of selenium is used yearly by the glass industry as a decolorizer to neutralize the greenish tint caused by iron compounds and for producing pink and ruby glasses. Selenium ruby glass is specified in railway and other signal lenses and is also used for decorative purposes.

Many applications of iron castings require the surface of the casting to be highly resistant to abrasion. Metallurgists have shown that four grams of tellurium (plus graphite) per ton of iron improves wear resistance of the finished casting. Small amounts of selenium and tellurium added to steel, copper, copper-rich alloys and bronze make these more easily cut and sawed. Tellurium added to lead or lead alloys greatly improves corrosion resistance and tellurium-lead increases in strength and toughness as it is rolled or stretched. Tellurium doubles the life of lead used in sulphuric acid plant construction. Tellurium also increases the strength and hardness of tin.

Selenium coatings adhere firmly to magnesium alloys and definitely reduce attack by sea water. Selenium also improves paint adherence. Selenium and tellurium compounds act as brighteners in some electroplating baths. Certain pigments known as the cadmium reds and oranges are formed when selenium is calcined with cadmium sulphide. These cadmium sulphoselenide pigments are characterized by having brilliant colors. About 1,000,000 lb. of them are produced yearly.

Metal selenides and tellurides act as hydrogenation and cracking catalysts for the conversion of heavy oils to motor fuels. Research has indicated commercial possibilities for selenium for use in motor oils and soap manufacture. Used in rubber, selenium and tellurium increase resistance to heat and abrasion. Both selenium and tellurium rubber are used as coverings on portable electric cables for jobs where the cable receives rough treatment.

R. S. Shutt and G. R. Waitkins, supervisor of the division of chemical research and research chemist, respectively, Battelle Memorial Institute, Columbus, Ohio, before the Division of Physical and Inorganic Chemistry, American Chemical Society, Columbus, Ohio, December 30, 1941.

• • •

Of the 400,000,000 lb. magnesium program, capacity for some 54,000,000 lb. has been completed. Electrolysis of $MgCl_2$ will account for 352,000,000 lb. and the Hansgirg carbo-thermal process for 48,000,000 lb. The original 400,000,000 lb. program will soon be increased to 725,000,000 lb., of which 157,000,000 lb. will eventually be produced by plants using the ferro-silicon processes.

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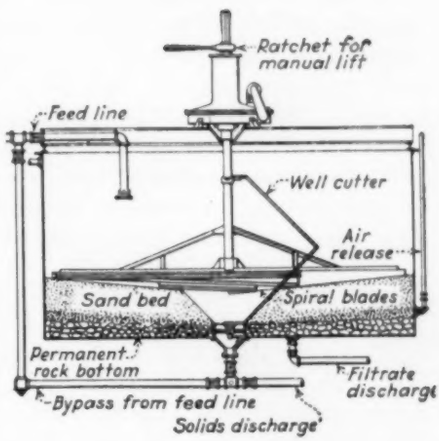

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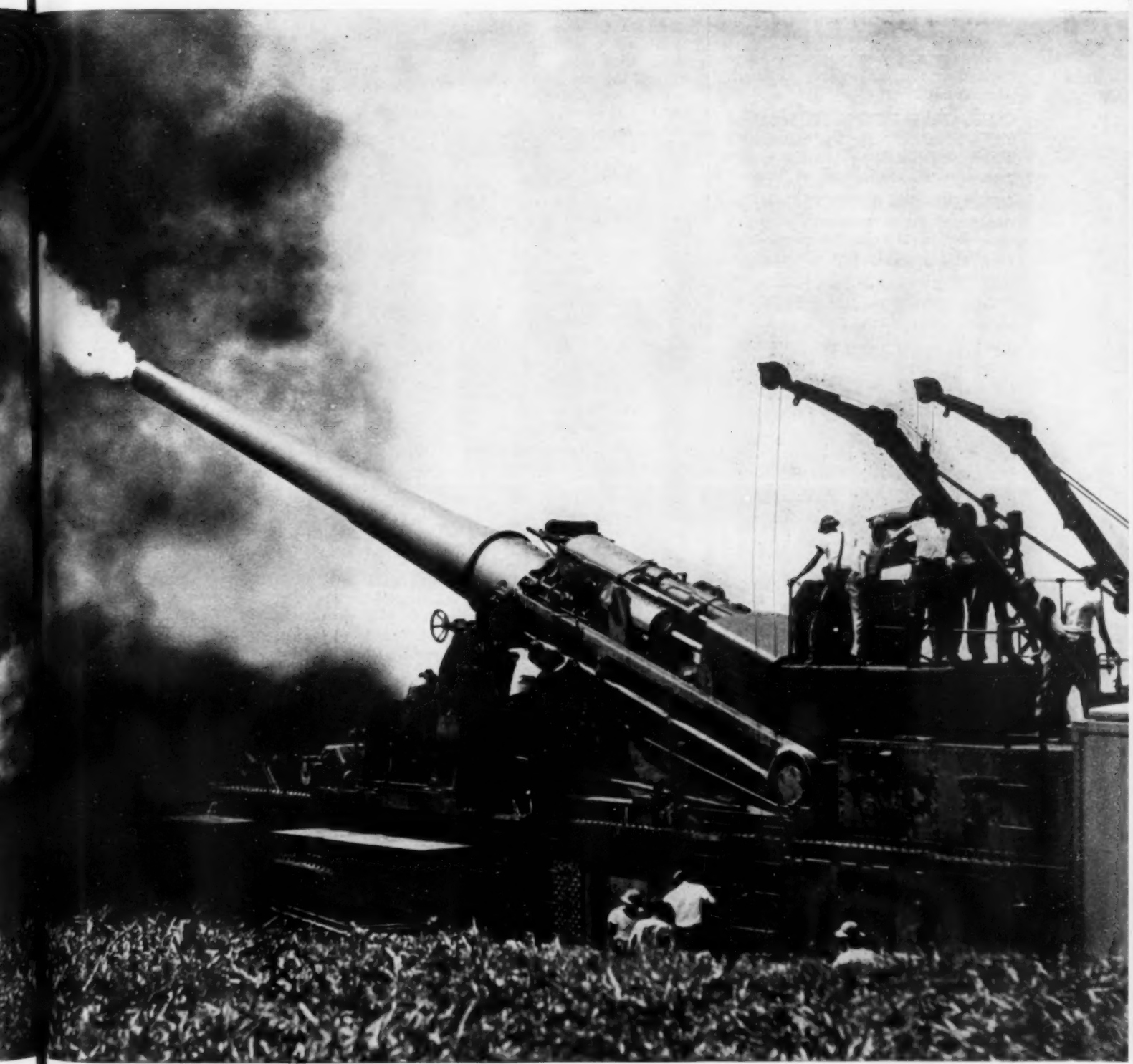

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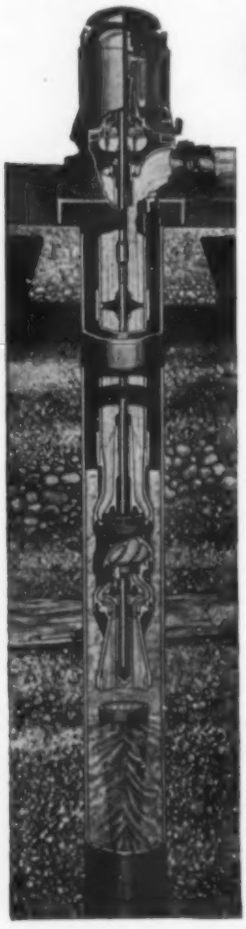

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SELECTIONS FROM CURRENT LITERATURE

OXIDE FILMS ON ALUMINUM

THE THICKNESS of protective oxide films on aluminum (applied by the "Eloxal" process) has been measured by dissolving the metal in ether and hydrogen chloride. In 16 minutes of electrolytic oxidation the Eloxal film reached a thickness of 6 microns; in 65 minutes it was 13.5 and in 3 hours 26.5 microns thick. The dielectric constant of the film remained constant at 7.58, indicating that the water in the film is held as water of hydration, not merely as adsorbed water. In very thin films the moisture content of the oxide was 14.44 to 15.05 percent but in thicker films it falls to about half that level, namely 7.5 to 7.8 percent. Evidently as the film thickens there is a cataphoretic loss of water of hydration. This is an effect which merits exact study. The ether-hydrogen chloride method of stripping eloxized aluminum agrees well with the methanol-bromine method.

Digest from "Stripping Eloxal Films From Pure Aluminum and Measuring Their Thickness," by W. D. Treadwell and A. Obrist, *Helvetica Chimica Acta* **24**, 998-1005, 1941. (Published in Switzerland.)

EXPRESSION OF CASTOR OIL

EFFECT of pressure, temperature and pressing time on castor oil yield have been studied. The castor seed used in the experimental studies contained 41.26 percent oil (ether extraction method) and 35.74 percent shell (dry basis). After dehulling, oil content of seed was 64.19 percent (dry basis). Seeds were ground and moisture content maintained at 6.5 percent by steaming. The pressure range studied varied from 1,000 to 4,000 lb. per sq.in., temperature from 20 to 60 deg. C. and pressing time from one to five hr. Effects can be expressed in the form of the equation:

$$W^2 = 0.350P\theta^{1/6} / (\mu/\rho)^{1/6}$$

where W is the weight percent of the yield of castor oil on the dry basis, P is pressure in lb. per sq.in., θ is pressing time in hours, and μ/ρ is kinematic viscosity in stokes. With the exception of a higher value for the constant, the expression is the same as that previously reported for sesame oil.

Digest from "Studies on Expression of Vegetable Oils, VII Expression of Castor Oil," by E. C. Koo, *Journal of Chemical Engineering* **VII**, 23–25, 1940. (Published in China.)

ION EXCHANGE WITH PERMUTIT

IN EXPERIMENTS with the chlorides of sodium, potassium and calcium in aqueous solution the adsorbent was saturated with sodium and calcium ions by washing with solutions of the chlorides. Excess electrolyte was then washed out with distilled water and the adsorbent was dried at 30 deg. C. Ion exchange experiments were then carried out with normal (N), 0.5N, 0.25N, 0.1N, 0.05N, 0.025N and 0.01N solutions of potassium chloride, sodium chloride and calcium chloride. Designating the anion of the adsorbent as P, theory requires that the reaction PNa + KCl must be independent of concentration since both cations are univalent. In the reaction P_2Ca + NaCl the adsorption of Na ion should decrease with decreasing concentration, and in the reaction PNa + $CaCl_2$ adsorption should increase with decreasing concentration since the cations differ in valence. The table shows that the theoretical predictions are correct.

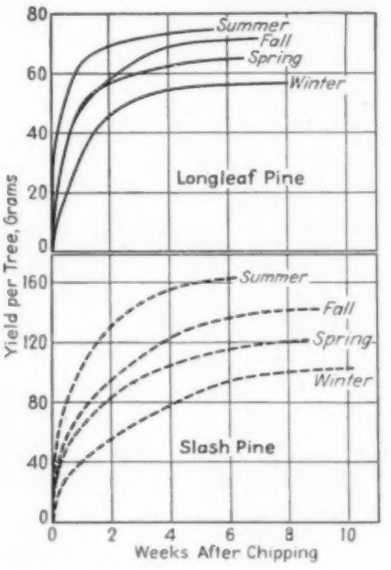
Salt conc., N	PNa + KCl	P_2Ca + NaCl	PNa + $CaCl_2$
1	193.1	197.0	125.0
0.5	189.0	176.0	135.4
0.25	186.2	150.7	148.3
0.1	195.1	135.7	161.4
0.05	192.6	125.0	170.8
0.025	191.0	113.0	179.2
0.01	190.3	....	186.4

The figures in the table represent milligram-equivalents of adsorbed cation per 100 g. of adsorbent.

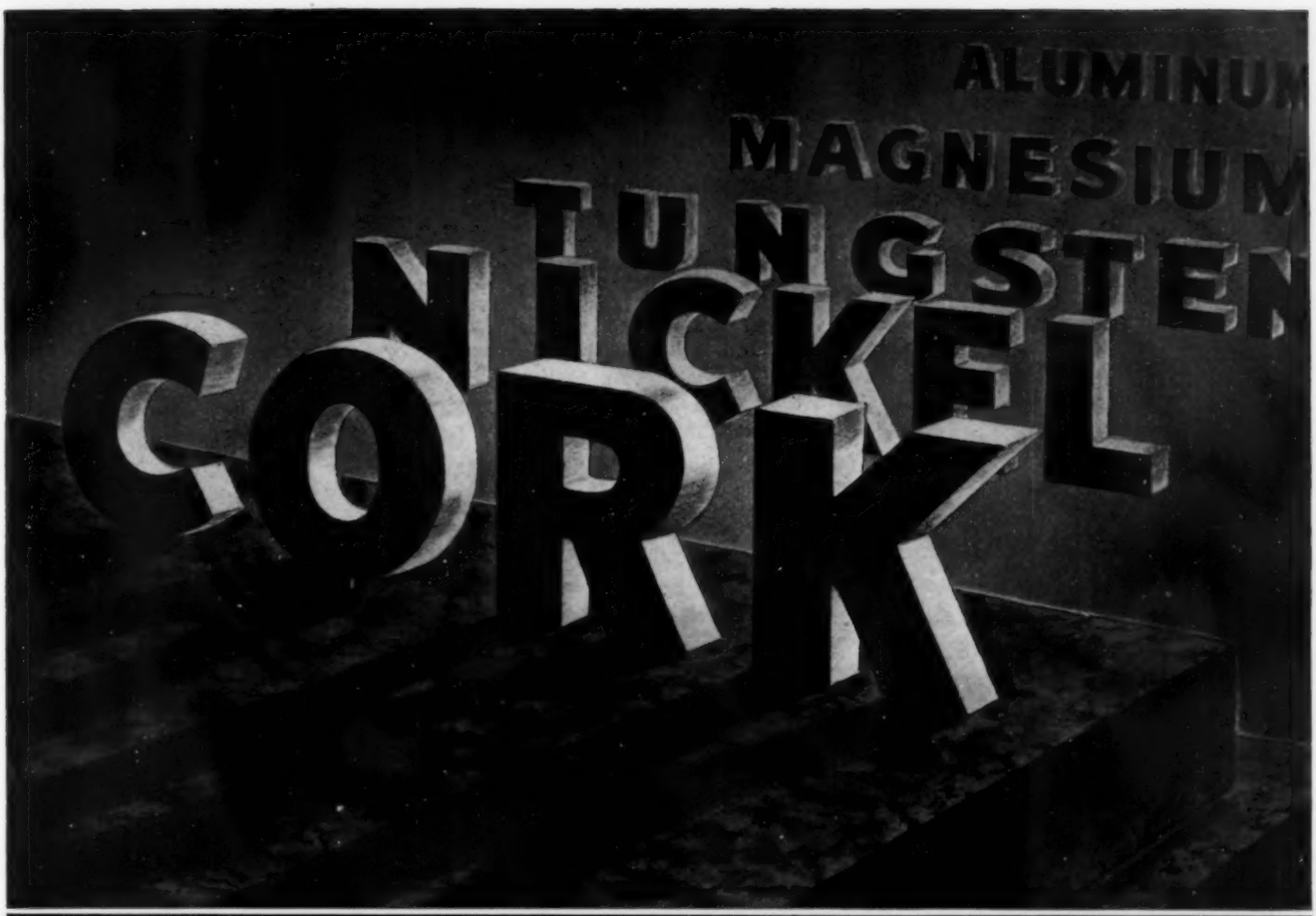
Digest from "Ion Exchange Between Solid and Liquid Phases. I. Relation of Cation Exchange to Concentration," by A. N. Ivanov and E. N. Capon, *Zhurnal Fizicheskoi Khimii* **15**, 659–64, 1941. (Published in Russia.)

NAVAL STORES YIELDS

CHIPPING schedules for obtaining gum from longleaf pine or slash pine vary considerably according to the season, labor supply, market for naval stores, intended subsequent disposition of the trees and other factors. For example, in a thick stand of timber the trees



selected for thinning can be rapidly exploited for maximum gum production by frequent chipping before they are cut down. Similarly, saw timber may be exploited for high gum output before logging. But systematic chipping for utmost economic utilization of turpentine sources calls for exact information concerning the effects of different chipping frequencies on gum



Why CORK is near the top of this list

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These characteristics make cork vital for hundreds of war uses. Cork insulation is needed for naval craft, and for food storages at Army and Navy bases. It is required for equipment in powder plants, oil refineries, and other vital chemical process plants which demand extremely low temperatures accurately maintained. There has never been an equal to cork for this type of service.

Naturally, these war needs are being met first with dependable Armstrong's Corkboard and Cork Covering. After them, cork insulation is being allotted for other uses —chiefly for food preservation. In recent months many meat packers, dairy operators, quick freezing plants, and others in the perishable food field have been supplied with Armstrong's Cork Insulation.

For your insulation needs . . .

If you're planning new insulated construction, call the nearest Armstrong office or distributor. Get authentic information about cork insulation deliveries. Your Armstrong Cork representative is an expert in his field. He will be glad to go over your plans and offer suggestions now which may save time and expense later on. If cork insulation can not be supplied for your work he will help you get other material. Armstrong Cork Company, Building Materials Division, 919 Concord Street, Lancaster, Pa.

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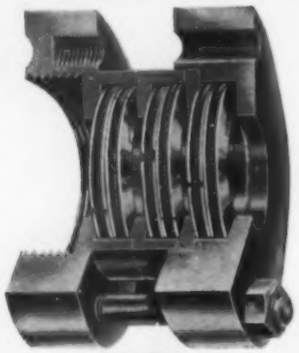

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yield. Such a study has been made over a period of several years. The results indicate that trees selected for long productive life rather than maximum immediate output should be chipped semiweekly in summer, weekly in spring and fall and semimonthly in winter. It was found, however, that trees can be chipped for high output in a single season without any excessive drain on the vitality of the timber. Even in exploited trees chipping should not be more frequent than three times a week in summer and biweekly in winter. Gum yield curves have been plotted for winter, spring, summer and fall chipping as a function of time after chipping (see chart).

Digest from "Relation of Naval Stores Yields to Frequency of Chipping," by T. A. Liefeld, *Journal of Agricultural Research* **64**, 81–92, 1942.

DESULPHURIZING GAS

SULPHUR bacteria occurring in peat can be utilized commercially in removing H_2S from watergas or coal gas in oxide boxes. The preferred procedure is to mix equal volumes of iron oxide and peat. The only significant change from current oxide practice in using this mixture is that a small proportion of ammonia (300 to 500 ppm.) must be added to the gas to activate the bacteria. Peat has the added advantage of making the oxide boxes lighter. Hydrogen sulphide is oxidized almost quantitatively to free sulphur. The mixture of peat and oxide is more active, and stays active longer, than bog ore alone. Combustion behavior in the spent oxide burners is good and the SO_2 concentration in the combustion gas is satisfactory. Young fibrous open-textured high moor peats are best for the purpose. Efficiency of desulphurization is hardly influenced by temperature between 5 and 30 deg. C. but is sensitive to the O_2:H_2S ratio, rising rapidly as this ratio increases up to about 0.8 and rising more slowly thereafter. Dry peat is inactive but in admixture with oxide it can be used at relatively low moisture content, e. g. 25 percent calculated on the peat, or less if wetting agents are present.

Digest from "Bacterial Removal of Hydrogen Sulphide from Watergas and Coal Gas by Peat and Peat: Oxide Mixtures," by R. Quarendon, *Journal of the Society of Chemical Industry* **60**, 267–77, 1941. (Published in England.)

FRETTING CORROSION

CONTACT faces of tightly fitted machine parts are subject to fretting corrosion if exposed to cyclic service stresses. Fatigue flaws often start from surfaces already damaged by such corrosion, especially in shafts with press-fitted pulleys and bearing races, and in axles with press-fitted wheels. An experimental machine for artificial production of fretting corrosion was used for test purposes since the stresses occurring in actual service conditions are not known. This machine reduced fatigue strength of a medium carbon steel from 18.5 to 16.1 tons per sq.

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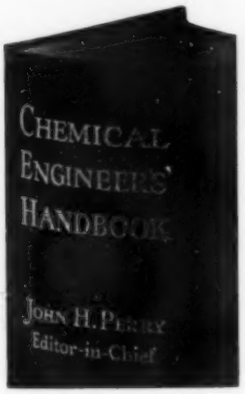

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in. (13 percent decrease). Fatigue strength of an alloy steel (Ni 2.61, Cr 0.68, Mo 0.56, Si 0.25, C 0.34, Mn 0.7, S 0.01, P 0.32 percent) was similarly reduced from 30.5 to 25 tons per sq. in. (18 percent decrease), but after the fretting corrosion layer was ground off the fatigue strength was the same as before the corrosion test. The medium carbon steel, on the other hand, recovered only part of its fatigue strength when ground (restored from 16.1 to 17 tons per sq. in.). Evidently fretting corrosion is essentially a surface phenomenon, but the test as so far developed needs some improvements to make it fully accurate.

Digest from "Fretting Corrosion and Fatigue Strength: Brief Results of Preliminary Experiments," by E. J. Warlow-Davis, *Proceedings of the Institution of Mechanical Engineers* **146**, 32–8, 1941. (Published in England.)

HEAVY DUTY PHOSPHORUS CAST IRON

THE PHOSPHIDE in phosphorus-containing cast iron is more fusible than iron and hence tends to lower the heat resistance of cast iron. Tests with loaded bars at 850 deg. C. show, however, that stiffness (rigidity) increases with increasing phosphorus content even at this high temperature. Thus a bar with 0.4 percent bent to twice the deflection of a bar with 1.1 percent phosphorus. A peculiar feature of cast iron is that the small initial strength loss caused by heat does not continue but is reversed above about 200-300 deg. C. so that full strength is regained at about 450-500 deg. C. At still higher temperatures strength decreases again. This is true of tensile strength, hardness and impact strength. Phosphorus does not alter this behavior to any significant extent. The effects of phosphorus on properties of cast iron, for each 0.1 percent increase in phosphorus content, may be summarized thus: tensile strength, 2.5 to 5 percent increase up to about 0.35 percent phosphorus, then a decrease at about the same rate; Brinell hardness, about a 4-point increase; impact strength, about 5 percent decrease; thermal conductivity, about 0.5 percent decrease.

Digest from "Second Report of the Research Committee on High Duty Cast Irons For General Engineering Purposes," by J. G. Pearce, *Proceedings of the Institution of Mechanical Engineers* **146**, 61–71, 1941. (Published in England.)

POTASH SALTS FROM SEAWATER

RECOVERY of potassium chloride as a by-product in the manufacture of salt from seawater has an economic obstacle in the fact that only one ton of potassium chloride is recovered for every 100 tons of salt. Search for a direct precipitation process which would overcome this obstacle led to the bitartrate method, based on the fact that potassium bitartrate is only 0.09 percent soluble. Technical application of bitartrate precipitation is simple and the reagent (tartaric acid) can be recovered

For the Difficult Processing Problem

Study the possibilities available through the use of a Sprout-Waldron crusher.

Illustrated is the "Precision Type" Crusher. This unit operates on a principle of rugged intermeshing circular saw tooth breaker plates which keeps excessive fines to a minimum.

This particular unit has proven applicable in crushing or shredding operations, such as the shredding of tin cans prior to detinning.

Other types of Sprout-Waldron crushers are being used in the reduction of burnt lime stone, preformed plastics, mineral rubber and a large variety of non-metallic materials.

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For Making Right-Angle Welded Branch Pipe Outlets of Full Pipe Strength

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BONNEY WeldOlets, ThredOlets and Socket-End WeldOlets are designed for making leakproof, right-angle branch pipe outlets of full pipe strength. Tees, crosses, side outlets, side outlets and crosses and double crosses . . . . any one or all can be made with these fittings.

The heavy, external rib and the wide bases or footings compensate for loss of strength in the main pipe when the button is removed and eliminate the need for extra braces or supports to take care of the vibrational stresses set up at these junctions.

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Because they provide wide, funnel-shaped outlets, WeldOlets, ThredOlets and Socket-End WeldOlets improve flow conditions and reduce turbulence and friction to a minimum.

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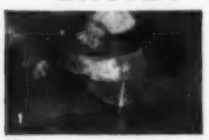
Standard, stock fittings (outlets from 1/4" to 12") in size-to-size and reducing sizes are of drop forged steel. On special order they can be furnished in sizes up to 24"x24". For special applications or where unusual conditions exist, they can be supplied in Toncan Iron, wrought iron, brass, Monel, Everdur, etc. WeldOlets, ThredOlets and Socket-End WeldOlets are suitable for every type of piping installation and for all commonly used pressures and temperatures.

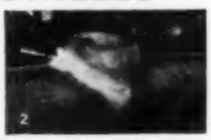
Your local distributor will be glad to tell you the complete story about savings which can be effected, or write for BULLETIN WT29—TODAY.

Socket-End WeldOlet

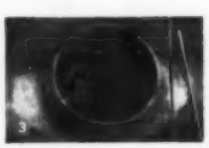
EASILY INSTALLED



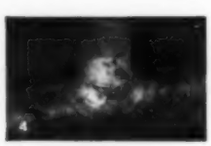
Mark center lines and tack the fitting into place.



Then weld the fitting to the main pipe.



Remove the button, which will also permit inspection of the inside of joint.



Then attach the branch pipe.

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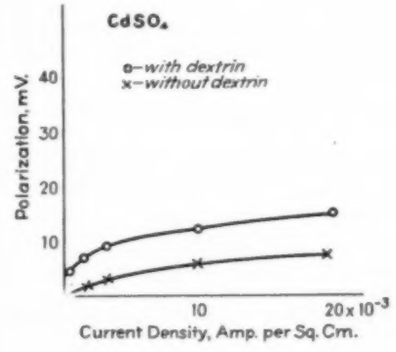
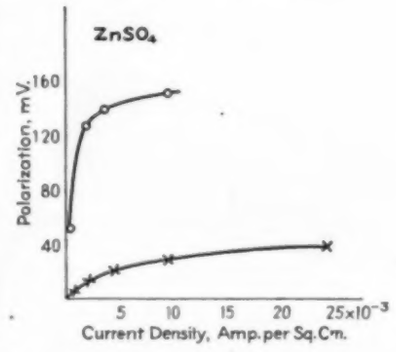
with not more than 1 percent loss on a pilot plant scale. The chemicals required to produce a metric ton of potassium sulphate by this method are: mother liquor from seawater, 20 cubic meters; tartaric acid, the molecular equivalent of the potassium; sulphuric acid, 1.2 metric ton; caustic soda, 0.6 metric ton. Actual consumption of tartaric acid is very small since it is recovered and used again. Another precipitation method which shows promise is Kielland's. The reagent is dipicrylamine, which is even more specific than tartaric acid. It can be added directly to seawater containing as little as 400 to 500 p.p.m. of potassium (calculated as the oxide). The sodium, calcium and magnesium salts are not precipitated; hence this method yields potassium salts which need no refining for ordinary technical uses. Dipicrylamine is recovered and used again.

Digest from "Extracting Potash Salts From Seawater," by L. Blas, *Ion* 1, No. 3, 11–3, 1941. (Published in Spain.)

ZINC AND CADMIUM PLATING

To ASCERTAIN the mechanism by which colloids such as dextrin modify the crystal structure of zinc and cadmium deposits, some comparative electroplating tests were made from saturated $ZnSO_4$ and $CdSO_4$ solutions with and without dextrin (0.3 gm. per 1.). It was found that deposition of Zn or Cd proceeds at a higher negative potential in presence than in absence of dextrin and that the deposit has a finely crystalline structure. Dextrin also has





the effect of increasing polarization at the moment of starting the current after a break in the circuit. High temperature has the opposite effect, decreasing polarization at this moment. The Zn or Cd deposit carries

down some dextrin with it. The dextrin content of the deposit is lower at high bath temperatures. The polarization effect of dextrin is illustrated by the curves, in which polarization is plotted as a function of current density.

Digest from "Study of the Mechanism by Which Colloids (Dextrin) Influence Electroplating With Zinc and Cadmium," by P. F. Mikhalev, *Zhurnal Fizicheskoi Khimii* **15**, 793–6, 1941. (Published in Russia.)

IRON FROM OXIDE ORES

THE ONLY commercially successful reagents for making iron and its chlorides by the chlorination method are chlorine and hydrogen chloride. It has been found that the action of hydrogen chloride on oxide ores completely removes iron and manganese from the ore as chlorides if the reaction temperature is raised to about 900 deg. C. At this temperature the chlorides of iron and manganese are volatile enough to be carried over in the gas current. Partial reduction of the ore with hydrogen accelerates the reaction with hydrogen chloride. For example, 99 percent conversion of Kreuzberg ferruginous sandstone was effected by 5 minutes of reduction and 20 minutes of reaction with hydrogen chloride at 700 deg. C. when the average particle size of the ore was 0.25 mm. With coarser ore (0.5 to 1 mm.) 95 percent conversion was obtained under the same conditions. Iron can be obtained by reducing ferric chloride with hydrogen, first to ferrous chloride and then to a pure powdery iron. The final reduction can be effected in a moderate period of time at 600 deg. C. Comparison of different iron ores showed that the method is applicable to all iron ores but that for commercial reasons it is best suited to making iron from low grade acidic ores.

Digest from "Research on Making Iron From Oxides and Oxide Ores With Hydrogen Chloride," by Ernst Diepschlag and Horst Meissner, *Zeitschrift für anorganische und allgemeine Chemie* **245**, 409–28, 1941. (Published in Germany.)

METHANE FROM REFUSE

THE MALCOLM method of sludge fermentation was investigated as to yield and composition of gas, composition and fertilizing value of residual sludge and nitrogen balance. Screened, triturated refuse was added daily to sewage sludge in two fermenters. The ratio of inoculant to sludge for each addition was 1:100 (calculated on organic matter.) Some experiments were made at 16 and others at 26.5 deg. C. One fermenter was used for determining organic matter, moisture, ash and pH in the initial and final products. Gas yield was determined in the other fermenter, in terms of organic matter, total carbon and carbon converted by fermentation. The nitrogen balance was also investigated in this fermenter.

Gas from the process contained 60-65 percent methane and 30-35 percent carbon dioxide, with small amounts of nitrogen, hydrogen and oxygen. High yield is favored by low ash content and

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For silicate information, turn to PQ Silicate Headquarters. Specific advices where particular conditions are known.

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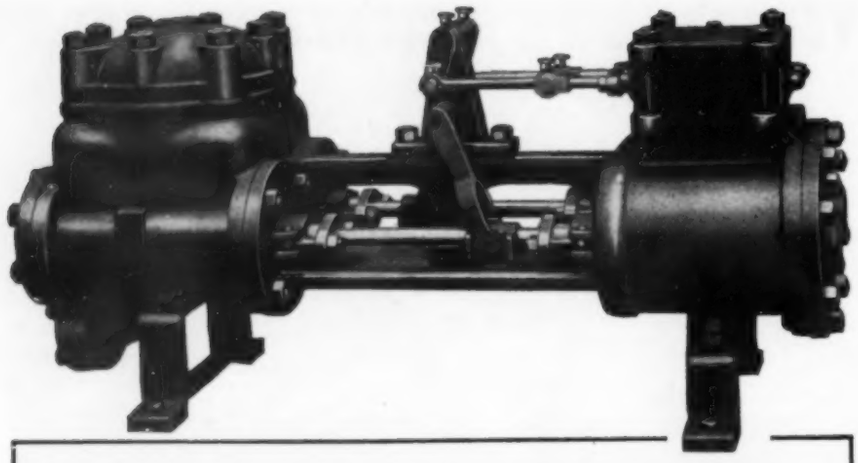

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by a low ratio of organic matter in the daily charge to organic content of the initial sludge. About 10 to 15 percent of the refuse is gasified, but on the basis of organic matter about 65 percent gasification is effected. The residual sludge is useful as fertilizer. Losses due to fermentation of organic nitrogen compounds with liberation of nitrogen gas are more effectively prevented by pretreatment with sulphuric acid than by formaldehyde, copper nitrate or mercuric sulphate.

Digest from "Methane Fermentation of Sewage," by U. Bertozzi, G. Roberti, E. Pera and A. Simonetti, *Ricerca Scientifica* **12**, 178–201, 1941. (Published in Italy.)

VANILLYL ALCOHOL

VANILLIN, in either of its isomeric forms, resists catalytic hydrogenation to the corresponding alcohol with the aid of palladinized barium sulphate or palladinized animal charcoal. It has now been found, however, that palladium is a potent catalyst for this hydrogenation if used in the form of Paal's colloidal palladium. With this catalyst, in alcoholic solution, *o*-vanillin readily yields *o*-vanillyl alcohol which is a new compound. Similarly, isovanillyl alcohol is readily obtained from isovanillin. These alcohols cannot be synthesized by the Cannizzaro reaction because they are resinified by strong alkali; hence the catalytic method offers a successful alternative method.

Digest from "Catalytic Reduction of o-Vanillin and Isovanillin," by F. Mauthner, *Journal für praktische Chemie* **158**, 321–4, 1942. (Published in Germany.)

CARBON BLACK

CARBON spheres in which the ratio of diameter to incident wave length is less than about 0.1 scatter incident light uniformly in all directions. The intensity of the scattered light for any angle is proportional to the square of the volume of the particle and inversely proportional to the fourth power of the wave length. As the ratio of diameter to wave length rises to 0.25 and to 0.5 and higher, the diffused light collects more and more into a main beam continuing the incident ray and becoming narrower as the ratio continues to increase. Blue light predominates in the scattered light. Particle size can be estimated (approximately) from the intensity, distribution and polarization of the light. This method can be utilized for calculating optical properties of carbon particles when their size is known, or for estimating particle size from optical behavior.

Digest from "Absorption of Light and Heat by Small Spherical Particles. II. Scattering of Light by Small Carbon Spheres," by R. Ruedy, *Canadian Journal of Research* **20A**, 25–32, 1942.

DEAD-PRESSED FULMINATE

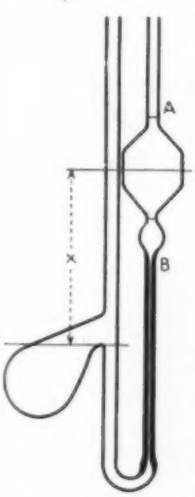
IN EXPLOSIVES of the detonator type the rate of combustion is so high, even at atmospheric pressure, that the increasing pressure rise at the front accelerates detonation. The sensitivity of Hg fulminate to loss of detonating power under excessive pressures is due to its

relatively slow rate of combustion. If its apparent density is raised too high by compression its capacity for sudden transition from combustion to detonation is destroyed. This loss of detonating power is attributable to close packing. The interstitial volume between crystals is diminished, penetration of hot gases through the interstices is impeded, and the rate of combustion falls below the minimum which is necessary for detonation. On this basis any expedient which will raise combustion velocity above the critical level should restore detonating power, and it is a fact that dead-pressed fulminate can be detonated by raising the temperature high enough. It has also been found by experiment that detonation under pressure raises the rate of combustion sufficiently to detonate dead-pressed fulminate. Thus a sample of Hg fulminate, compressed under a pressure of 5,000 kg. per sq.cm., was sealed in an iron tube with a lead cover to prevent escape of gases. When the resulting pressure reached about 500 kg. per sq.cm. the fulminate detonated satisfactorily.

Digest from "Dead-Pressing Mercury Fulminate," by K. K. Andreev. *Comptes rendus (Doklady) de l'academie des sciences de l'URSS* 31, 456–8, 1941. (Published in Russia.)

SIMPLE VISCOMETER

A MAJOR disadvantage of the standard U-tube viscometer is that an exact volume of liquid must be introduced. The tube must not be wetted above the mark nor allowed to froth. Hence a filling device is required and it must be cleaned and dried between samples. Another result is that the viscometer must be emptied, cleaned, dried and refilled if the temperature of measurement is changed. An improved viscometer has been designed in which the dimensions of the standard instrument are retained excepting that 8 mm. tubing is used above the mark. Its construction is illustrated in the drawing. The instrument is filled by pouring liquid down the side of the tube to avoid air bubbles. It is then tilted so that liquid is drawn above the mark, where it is held. The liquid must be overflowing when it passes the first mark and the side bulb must not be full when flow ceases. When the necessary thermostats are set up this viscometer is much less troublesome to use than the Redwood viscometer. Its calibration does not vary with time of flow nor with temperature.



Digest from "A Simple Viscometer," by W. C. G. Wheeler, *Journal of the Society of Chemical Industry* 60, 300, 1941. (Published in England.)

6 WAYS* TO DO A BIGGER WAR JOB WITH STAINLESS STEEL EQUIPMENT

#1. Specify the Correct Finish For Every Application

Doubly important in these days of Victory Production are the factors which enhance corrosion resistance—save man hours and cleaning time—add to the life of processing equipment.

Surface finish is one of these important factors. An engineer or plant man in selecting equipment for pasteurizing dairy products would expect to have equipment with a higher finish than would an engineer purchasing a heat resistant furnace alloy. In general additional grinding and polishing adds to the corrosion resistance and serviceability of processing equipment.

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No additional filtering equipment required in any of above cases.

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TRUE STEEL. The story of George Matthew Verity and his associates. By *Christy Borth*. Published by the Bobbs-Merrill Co., Indianapolis, Ind. 320 pages. Price $3.

Reviewed by *S. D. Kirkpatrick*

THE JOURNALIST-AUTHOR of that popular account of chemurgy called "Pioneers of Plenty," has now turned his undoubted talents to a different form of biography—the life story of an industrial corporation and the men and women responsible for it. He is fortunate in having selected for the subjects of this biography, the American Rolling Mill Co. and its remarkable founder, Mr. Verity. In few other industries of our country is there a comparable record for achievement of human and social values, as well as technological progress and business success. Mr. Borth has produced an intensely interesting, almost dramatic, history of the life of Armco's founder, who started out in 1884 as a grocery clerk, shifted into the iron roofing business three years later, and at the end of the last century, had worked himself into a strategic position in the steel industry. The company which he founded, Dec. 2, 1899, was destined not only to have a phenomenal growth, but to prove a major force in advancing technology and human relations in industry. It pioneered in many employer-employee policies that have since been widely accepted. Its relation to the community of Middletown in which it operates, has often been cited as a model of wholesome living without the blight of paternalism. Its most spectacular technical achievement was perhaps the development of the continuous wide-strip rolling mill, a process which has been licensed to the whole industry and has had a revolutionary effect on the manufacture of sheet steel. The activities of its research department, for which new laboratories were dedicated a few years ago, are a continuing record of successful battles in the combatting of corrosion and developing improved metals, alloys, paints, and plastics.

But the real story is that of George Matthew Verity, who today is approaching his eightieth birthday with the same energy, enthusiasm and success that have made him the great humanizer of American industry—"True Steel," tried and tested.

HANDBOOK OF CHEMISTRY AND PHYSICS. 25th edition. Edited by *C. D. Hodgman* and *H. N. Holmes*. Published by the Chemical Rubber Publishing Co., Cleveland, Ohio. 2,503 pages. Price $3.50.

THE twenty-fifth edition of this perennial favorite incorporates a few changes and improvements. Revisions are noted in the "plastics comparator" table. Tables of photographic film and plate speeds have been radically changed; a number of items having been excluded and a column for G.E. meter readings added. Tables of properties of amino acids have been revised and several new tables added. Material which appears in the previous edition and which was omitted from the twenty-fifth includes the 11-page qualitative analysis scheme, the four-page method of solving chemical problems and 53 pages of interest tables.

INDUSTRIAL CATALYST

ANHYDROUS ALUMINUM CHLORIDE IN ORGANIC CHEMISTRY. By *C. A. Thomas*. A. C. S. Monograph Series No. 87. Reinhold Publishing Corp., New York, N. Y. 972 pages. Price $15.

Reviewed by *R. H. McCormack*

THIS is a timely book for the Chemical Engineer. As the author says in his Introduction, "Today we have in aluminum chloride an extremely effective catalyst for syntheses in aromatic and aliphatic chemistry." Never before has there been such a necessity for the creation of new materials and the author has made it possible by his clear, concise, yet complete treatment of anhydrous aluminum chloride and the reactions which it promotes, to ascertain in a minimum of time whether or not this catalyst should be considered.

The book carries out well the general purpose of the Monographs—"to present the knowledge available upon the chosen topic in a form intelligible to those whose activities may be along a wholly different line."

The last four chapters on Polymerization, Anhydrous Aluminum Chloride in the Petroleum Industry, Preparation, Manufacture and Purification of Anhydrous Aluminum Chloride, Notes on Application of Anhydrous Aluminum Chloride, contain much of particular interest to Chemical Engineers.

The author makes no attempt to give details of all the numerous reactions discussed. His method of presentation of a great many of these in tabular form is admirable. Abundant references make it possible for anyone interested in so doing to round out any particular section of this monograph.

GLASS, THE MIRACLE MAKER. By *C. J. Phillips*. Published by the Pitman Publishing Corp., New York, N. Y. 415 pages. Price $4.50.

THERE are many people to whom the story of glass is of interest and importance: architects, artists, industrial designers and executives, as well as mechanical, electrical, civil and chemical engineers. And each of these will find something of value in this volume. Neither textbook nor popularized science, it presents factual information on the history, manufacture and uses of an age-old but tremendously important material. The story is well told in an interesting manner and is profusely illustrated with halftones and charts.

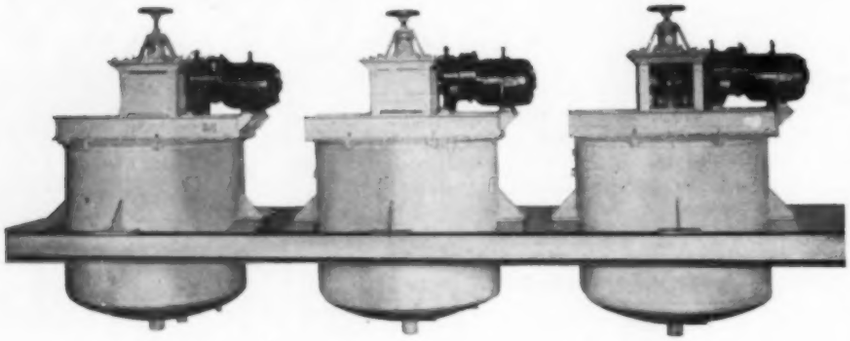
NO SHORTAGE HERE

PHYSICAL AND CHEMICAL METHODS OF SUGAR ANALYSIS. Third edition. Edited by *C. A. Browne* and *F. W. Zerban*. Published by John Wiley & Sons, New York, N. Y. 1,353 pages. Price $15.

Reviewed by *G. T. Reich*

THE GREAT wealth of new subject matter incorporated and the obsolete matter omitted from the third edition, compels consideration of the book as a new issue altogether. It describes all physical and chemical methods pertaining to the analysis of sugars and as the authors state also "to the analysis of accompanying substances which, although not belonging to the sugars, have nevertheless an important bearing on the chemical behavior of sugars and their complex technological, physical and physiological relationship." It covers a vast field of chemistry.

The book is divided into 17 Chapters, each with appropriate subdivisions. The great importance of the proper sampling of sugar and sugar products is described very thoroughly in Chapter I. The following two chapters deal with the determination of moisture by methods of drying and densimetric methods of analysis. Chapter IV is devoted to methods of estimating the percentage of sugars in solution by means of the refractive index. The theory and descriptions of the polarimeters are given in the next 35 pages; while in Chapter VI, the theory and descriptions of saccharimeters are covered in 58 pages. Polariscope accessories and specific rotation of sugars are treated in Chapters VII and VIII, while methods of simple polarization and invert double polarization are discussed in Chapters IX and X. The description of the physical methods for the examination of sugar and sugar solution in Chapter XII required 144 pages. The following four Chapters discuss the qualitative methods for the identification of sugars; reduction methods for determining sugars, special quantitative methods for the analysis of glucose in honey; maltose in the presence of sucrose, glucose, and fructose; fructose; pentoses and pentosans; pentoses and methyl pentoses in mix-



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tures and for many other sugar mixtures. The last chapter, XVII, presents practical applications of the principles and methods described in the preceding chapters and gives helpful instructions for other practical selected procedures. Finally, 109 pages of sugar tables close this very comprehensive book.

Those who know the authors and their broad knowledge of the sugars and related products, expected just such an up-to-date treatise. The well written, clear print, 332 illustrations, diagrams and tables, subject and author indexes, enhance the value of this book. It is indispensable not only to the chemists who are engaged in the manufacture of sugars, starch or related products but should prove of great value to scientists using instruments of these industries.

EYE HAZARDS IN INDUSTRY. By *Louis Resnick*. Published for the National Society for the Prevention of Blindness by the Columbia University Press, New York, N. Y. 321 pages. Price $3.50.

WE ALL know that American industry pays a tremendous annual price for avoidable accidents. For preventable injuries to the eyes alone, it is estimated that total compensation cost is more than $100,000,000 annually. This high figure is regrettable on other counts than dollars—suffering and blindness of workers, as well as hinderance of our all-out war efforts are represented. It is to reduce these items of pain, expense and wasted time that this volume has been written and published.

In two parts, each with five chapters, the book outlines the problem and its solution. The first part covers eye hazards, accidents and diseases, defective vision and first aid. The second part includes descriptions and discussion of mechanical guards and proper lighting. Employer as well as employee education is included as is a chapter on administrative supervision. There is also a brief section on process revision which points out instances where minor changes in procedure resulted in greatly reduced accident frequency.

The chemical process industries have established a good safety record even though many of the materials handled and the processes involved are dangerous. The record may be improved and this book will help. It may be recommended to all who are connected with accident prevention generally and sight conservation in particular.

INDUSTRIAL ACCIDENT PREVENTION. Second Edition. By *H. W. Heinrich*. Published by the McGraw-Hill Book Co., New York, N. Y. 448 pages. Price $3.

WHILE the book described above deals specifically with eye hazards, this one is an approach to the entire subject of accident prevention. It presents, in its 15 chapters, an over-all picture of industrial accident causes with corrective and preventive methods. Numerous case histories throughout the text em-

phasize various hazards and means for their reduction.

Revisions have been made in the new edition to increase clarity, consistency, and convenience. New chapters include "Basic Philosophy of Accident Prevention," "Creating and Maintaining Interest in Safety," "Occupational Disease," "Fatigue," and "Safety Organization—First Aid and Hospital."

The revised edition is a timely addition to current literature on industrial safety and of special value now because of its emphasis on the control of factors of accident occurrence when so much depends on the maintenance of production.

MATERIALS OF ENGINEERING. Sixth edition. By *H. F. Moore*. Published by the McGraw-Hill Book Co., New York, N. Y. 454 pages. Price $4.

IT IS hardly necessary to prepare an exhaustive description of a revision of a book as old or as well known as Professor Moore's. It is sufficient to point out that the new edition contains a new chapter on plastics which follows the general style of the rest of the book and presents much general information and other new material has been added to discussions of creep, failure by fracture, crystalline structure of metals, and rubberlike materials. In addition to technical schools, this rather elementary text would probably be found useful in defense training courses for training and upgrading inspectors, machinists and others.

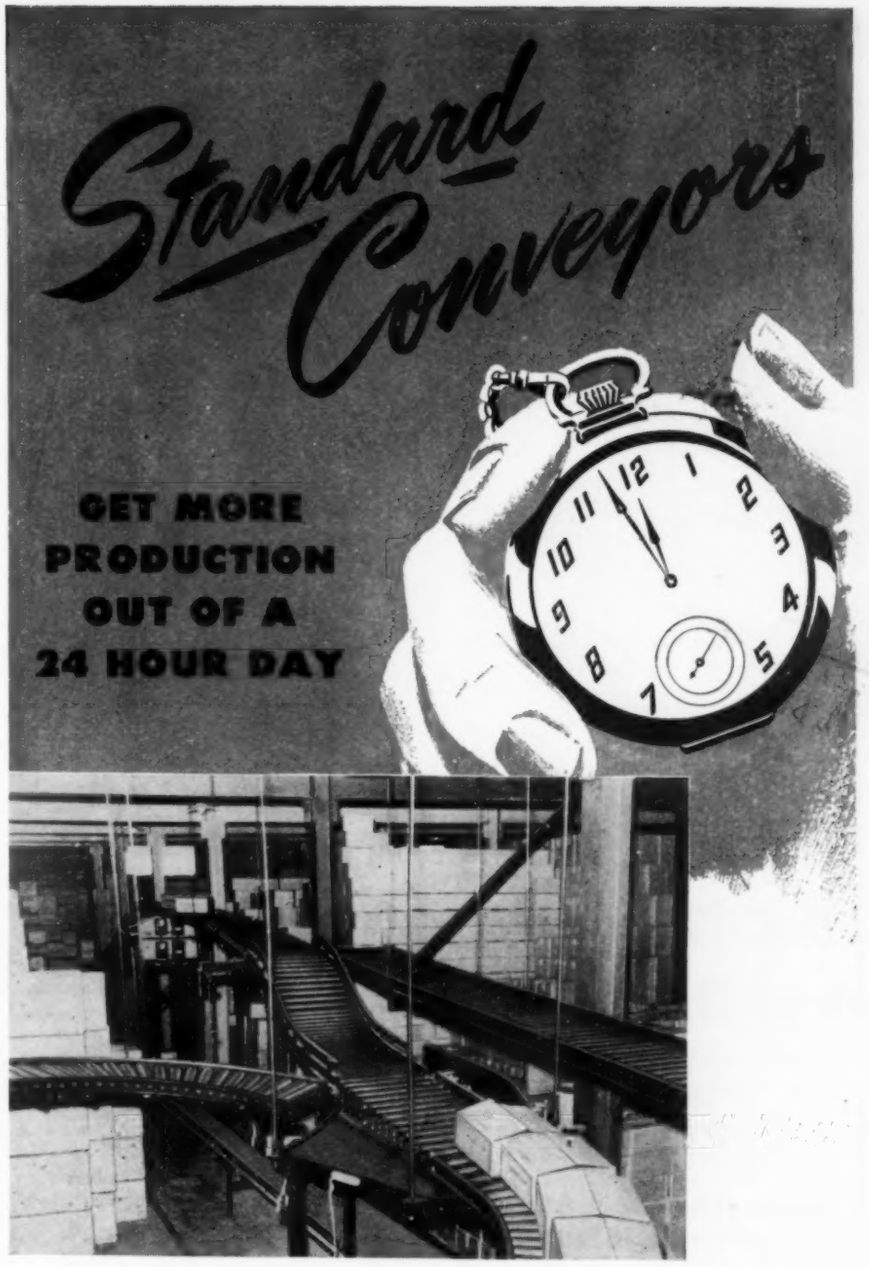
STEAM FOR INDUSTRIAL PROCESSING AND POWER. Edited by *E. Mulloy*. Published by Chemical Publishing Co., Brooklyn, N. Y. 112 pages. Price $2.

Reviewed by *T. R. Olive*

THIS book is one of a group designated as the "Complete Engineer" series. Although it is not so stated, it was prepared in England and is based on English practice, witness some of the expressions unusual to American ears, such as "pass-out" turbines. The publishers have seen fit to reproduce the book by some sort of photo-offset process, with particularly unfortunate results so far as the illustrations are concerned. This, however, is not the only evidence that the book has been hastily and carelessly thrown together. Perhaps it may be of value to so-called "stationary engineers" and other boiler room attendents but it is much too elementary for chemical and mechanical engineers.

EXPERIMENTAL PHYSICAL CHEMISTRY. Third edition. By *Farrington Daniels, J. H. Mathews* and *J. W. Williams*. Published by McGraw-Hill Book Co., New York, N. Y. 460 pages. Price $3.50.

OF THE 72 experiments in this revised edition, there are 15 new ones and 11 which have been revised extensively. Among the new experiments are: The gas density balance, photoelectric colorimetry, spectrophotometry, decomposition potentials, photohydrolysis, and



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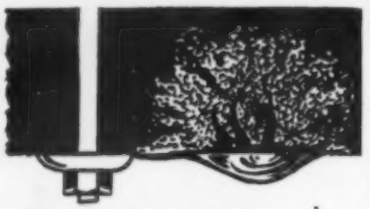

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spectrography. The general scheme of presentation remains the same: Discussions of theory, procedure, calculations, practical applications, suggestions for further work and references are given.

EXPERIMENTAL PHYSICAL CHEMISTRY. By *W. G. Palmer*. Published by Cambridge University Press, The Macmillan Co., New York, N. Y. 321 pages. Price $2.75.

Reviewed by *F. C. Nachod*

THIS book takes a place between a textbook and a laboratory manual. An understanding of physical chemistry is approached from the practical side, teaching the subject matter through experiment. The material is divided into eight chapters dealing with measurements of gas and vapor density, properties of crystals, solutions, thermochemistry, ionization, reaction rates, and surface chemistry. The reader will find the book very similar in conception and representation to Alexander Findlay's "Practical Physical Chemistry." Just as the latter, it can be recommended for the instruction and guidance of undergraduates.

HIGH POLYMERIC REACTIONS. By *H. Mark* and *R. Raff*. Published by Interscience Publishers, Inc., New York, N. Y. 476 pages. Price $6.50.

THIRD of the series on high polymers, this volume deals with theory and practice. It is divided into two parts. The first, or general part, includes general relationships and discusses quantitatively the structure of high polymers giving considerable data on experimental methods including physical and chemical tests, as well as methods of preparation and measurement of reaction rates. In the second part, the reported polymerization reactions of more than a hundred organic and inorganic compounds are reviewed and summarized.

In the past ten years great advances have been made in our knowledge of elementary molecular processes and it is one of the aims of Drs. Mark and Raff to present this information for all who may be interested. Chemical engineers concerned with the subject of polymerization will find this book a well organized summary of the work that has been done to date.

CHEMICAL SOLUTIONS. By *Frank Welcher*. Published by D. Van Nostrand Co., Inc., New York, N. Y. 404 pages. Price $4.75.

DESIGNED primarily for research and laboratory chemists, biologists, bacteriologists, teachers and students, this book is actually a complete dictionary of special solutions and reagents used as indicators, stains, fixatives, culture media, test reagents and etching solutions. Each is listed alphabetically under the name by which it is best known. An index of reagents classified according to uses is valuable in locating solutions and in suggesting

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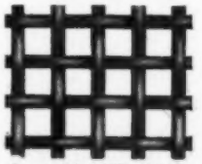

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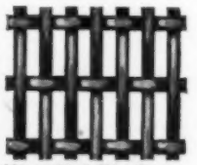

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other reagents for various tests. It is very helpful, for example, to look up "nitrite" and find a list of 21 reagents that can be used in identifying and determining this radical. Other examples: there are 43 reagents listed for albumins, 31 for blood, 19 for copper, 116 as culture media, 39 for glucose, 12 for potassium, 162 for staining purposes, 12 for vitamin C, and 12 for aldehydes.

Under each reagent there is factual and concise information classified under the heads of use, preparation, procedure for test, sensitiveness, remarks and reference. Altogether, this dictionary is comprehensive, well organized and represents a good printing and binding job. For all researchers, laboratory technicians and others who frequently use test and special reagents, it should prove welcome. It will be valuable in reducing the man-hours often spent in wasteful, and sometimes futile, efforts to isolate, digest and condense some needed information from the growing vastness of the chemical literature.

FEDERAL RESERVE CHART BOOK II, SECOND EDITION, FEBRUARY 1942. Published by the Board of Governors of the Federal Reserve System, Washington, D. C. 233 pages. Price $1.00.

THE Federal Reserve Board has issued a book of charts on Industrial Production entitled "Federal Reserve Chart Book II, Second edition, February 1942." Twenty-nine charts are shown for durable manufactures, approximately 75 are shown for non-durable manufactures, 12 for minerals, and half-a-dozen are summary charts. The charts in this book are principally 2-page charts showing monthly index-figures from 1919 through October 1941 with additional space for drawing in the charts through 1946. Two curves are shown on each, one with and one without adjustment for seasonal variation.

All the indexes shown in this chart book are compiled in the Board's Division of Research and Statistics and are published regularly in the Federal Reserve Bulletin. Back figures may be obtained upon request. The sources of the underlying data, the relative importance of each series in the base period, and the seasonal adjustment factors for 1942 are given in the last pages of this chart book. Descriptive material concerning the index was published in the Bulletins for August 1940 and September 1941.

Although only a single chart is shown for "chemicals" there are many charts which cover chemical process industries. For example, there are charts for leather tanning, many paper products, petroleum and coal products, and rubber products.

The volume is a 233-page looseleaf book approximately 10x15 inches. Each chart runs from zero to the appropriate maximum percent which fits the industry operations and each is on a scale approximately one year to the inch.

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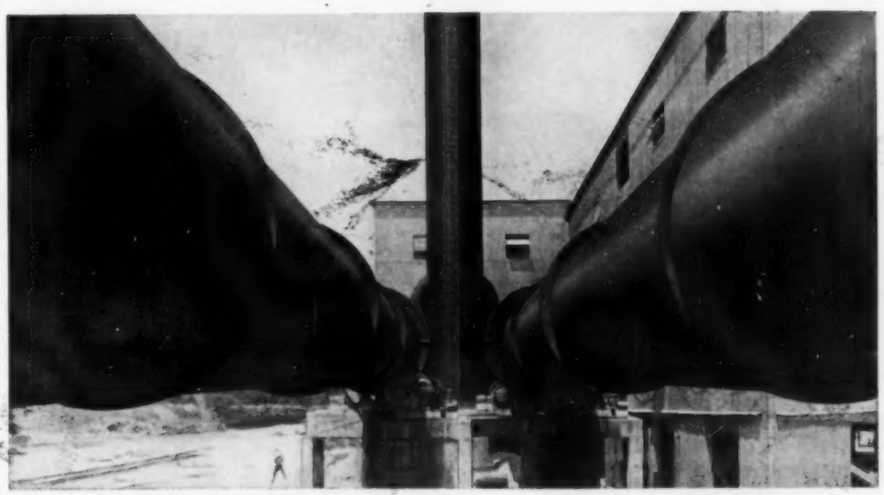

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RECENT BOOKS and PAMPHLETS

Geophysics in War. By *C. A. Heiland.* Colorado School of Mines Quarterly, Vol. 37, Number 1. Published by the Colorado School of Mines, Golden, Colorado. 85 pages. Price $1. Discusses and illustrates the theories of geophysics and their practical applications in war for military operations such as airplane and submarine detection, location of hostile weapons, harbor surveillance, remote control demolition, etc. Considerable space is also devoted to the details of geophysical prospecting for mineral resources such as oil, coal and lignite, water supply, and strategic minerals such as bauxite, alunite, chromite and ores of tungsten, mercury, nickel, manganese and others.

Engineering as a Career. Published by the Engineers' Council for Professional Development, New York, N. Y. 36 pages. Price 10 cents. A vocational guidance booklet on engineering, intended for the use of high school students and their advisors. Gives a general picture of the characteristics and requirements common to all branches of the profession and discussing the qualities and aptitudes needed by engineers.

A Manual of Phosphates. By *Vincent Sauchelli.* Published by the Davison Chemical Corp., Baltimore, Md. 94 pages. Contains much information pertaining to different branches of the general subject of phosphorus as a plant nutrient. Facts and data have been selected from many authorities and are presented in non-technical language.

Acids and Bases. A collection of papers published by the Journal of Chemical Education, Easton, Pa. 103 pages. Price $1. Number one in a series of Contributions to Chemical Education, this booklet presents nine papers by seven well-known educators. Written primarily for teachers and students of chemistry to aid them in keeping up-to-date on modern concepts.

The Polarographic Method of Analysis. By *Otto H. Müller.* Published by the Journal of Chemical Education, Easton, Pa. 114 pages. Price $1. Number two of the series mentioned in the preceding item, this small book reviews electroanalytical methods and apparatus, discusses fundamentals of quantitative and qualitative analysis, and gives applications. Eight general polarographic references are given.

GOVERNMENT PUBLICATIONS

The following recently issued documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. In ordering publications noted in this list always give complete title and the issuing office. Remittances should be made by postal money order, express order, coupons, or check. Do not send postage stamps. All publications are in paper cover unless otherwise specified. When no price is indicated, pamphlet is free and should be ordered from Bureau responsible for its issue.

Explosives regulations. Requirements of the U. S. Bureau of Mines for enforcement of the Federal Explosives Act providing licenses for manufacturers, purchasers, and users of explosives or explosive ingredients. Federal Register, January 16, 1942. Price, 10 cents.

Strontium Minerals, by Charles L. Harness. Bureau of Mines Information Circular 7200; mimeographed.

Survey of Fuel Consumption at Refineries in 1940, by G. R. Hopkins. Bureau of Mines Report of Investigations 3607; mimeographed.

Lightweight Aggregates for Concrete, by Forrest T. Moyer. Bureau of Mines Information Circular 7195; mimeographed.

Investigations During 1938, 1939, and 1940 of Combustibles in Manholes in Boston, Mass., by G. W. Jones, T. H. Haines, T. F. Smith, and W. J. Huff. Bureau of Mines Report of Investigations 3604; mimeographed.

Beneficiation of Alunite, by Alton Gabriel and John Dasher. Bureau of Mines Report of Investigations 3610; mimeographed.

Ore-Dressing Studies of Manganese Ores; Concentration of Manganese Ores from the Drum Mountain District, Utah. By S. R. Zimmerley, J. D. Vincent, and C. H. Schack. Bureau of Mines Report of Investigations 3606; mimeographed.

Hydrometallurgical Studies of Manganese Ores; Recovery of Manganese from Chamberlain Nodules by the Reyerson Modification of the Sulfur Dioxide Leaching Process. By C. E. Wood, C. L. Wallfred, E. P. Barrett, L. J. Reader, S. I. Ginsberg, W. F. Wyman, and R. L. Evans. Bureau of Mines Report of Investigations 3609; mimeographed.

Biennial Report of the Petroleum and Natural Gas Division, Fiscal Years 1940 and 1941, by R. A. Cattell, G. B. Shea, and others. Bureau of Mines Report of Investigations 3616; mimeographed.

Tentative Coal Mine Inspection Standards. A safety code. Bureau of Mines Information Circular 7204; mimeographed.

Sponge Chromium, by C. G. Maier. Bureau of Mines Bulletin No. 436. Price, 20 cents.

New Federal Reserve Index of Industrial Production. Federal Reserve Board.

Methods for Laboratory Technicians. Prepared under direction of the Surgeon General, War Department Technical Manual TM 8-227. Price, 50 cents.

Suggested Regulations for Retail Stores for Blackouts—Air Raids. Office of Civilian Defense.

Protective Concealment. Office of Civilian Defense.

Flexible Glues for Bookbinding. Technical Bulletin No. 24. Government Printing Office.

Field Studies of Insecticides Used to Control Cabbage Caterpillars in the South. By W. J. Held, Jr., Chas. E. Smith, W. A. Thomas, and L. B. Reed. Department of Agriculture Technical Bulletin No. 782. Price, 10 cents.

Studies on the Control of Cabbage Caterpillars with Derris in the South. By W. J. Reid, Jr., C. E. Smith, L. B. Reed, and C. O. Bare. Department of Agriculture Circular 615C. Price, 10 cents.

Relative Effectiveness of Acid Lead Arsenate and Other Materials as Stomach Poisons for the Larvae of the Japanese Beetle. By Walter E. Fleming. Department of Agriculture Technical Bulletin 788T. Price, 10 cents.

Harvesting Pyrethrum, by A. F. Siwers, M. S. Lowman, and W. M. Hurst. Department of Agriculture Circular 581C. Price, 5 cents.

Testing of Glass Volumetric Apparatus. National Bureau of Standards Circular C434. Price, 10 cents.

Sources of Information on Paint and Related Materials. National Bureau of Standards Letter Circular LC 671. Mimeographed.

List of Commercial Standards. National Bureau of Standards Letter Circular LC 676. Mimeographed.

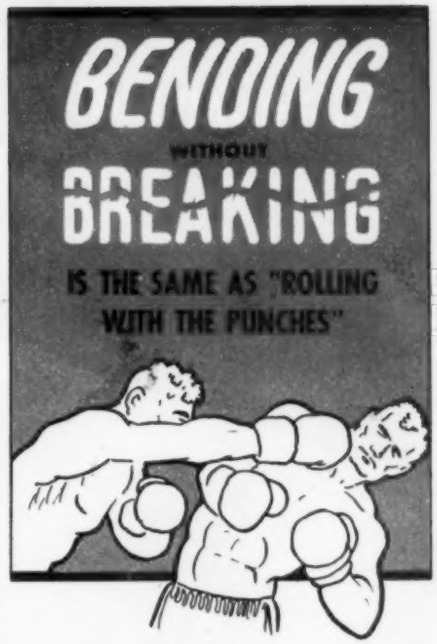
Luminous and Fluorescent Paints. National Bureau of Standards Letter Circular LC 678. Mimeographed.

Standardization Activities of National Technical and Trade Organizations. By Robert A. Martino. National Bureau of Standards Miscellaneous Publication M169. Price, 75 cents (Buckram).

Mica Reports. Immediately available for consultation at Washington office of U. S. Geological Survey are manuscript copies of forthcoming publications entitled "Muscovite in the Spruce Pine District, North Carolina," and "Mica-bearing Pegmatites of New Hampshire." Copies cannot be distributed or loaned.

Tungsten Deposits in the Sierra Nevada Near Bishop, California. A Preliminary Report. Geological Survey Bulletin 931-E, Department of the Interior. Price, 35 cents.

Chromite Deposits of Kenai Peninsula, Alaska. Geological Survey Bulletin



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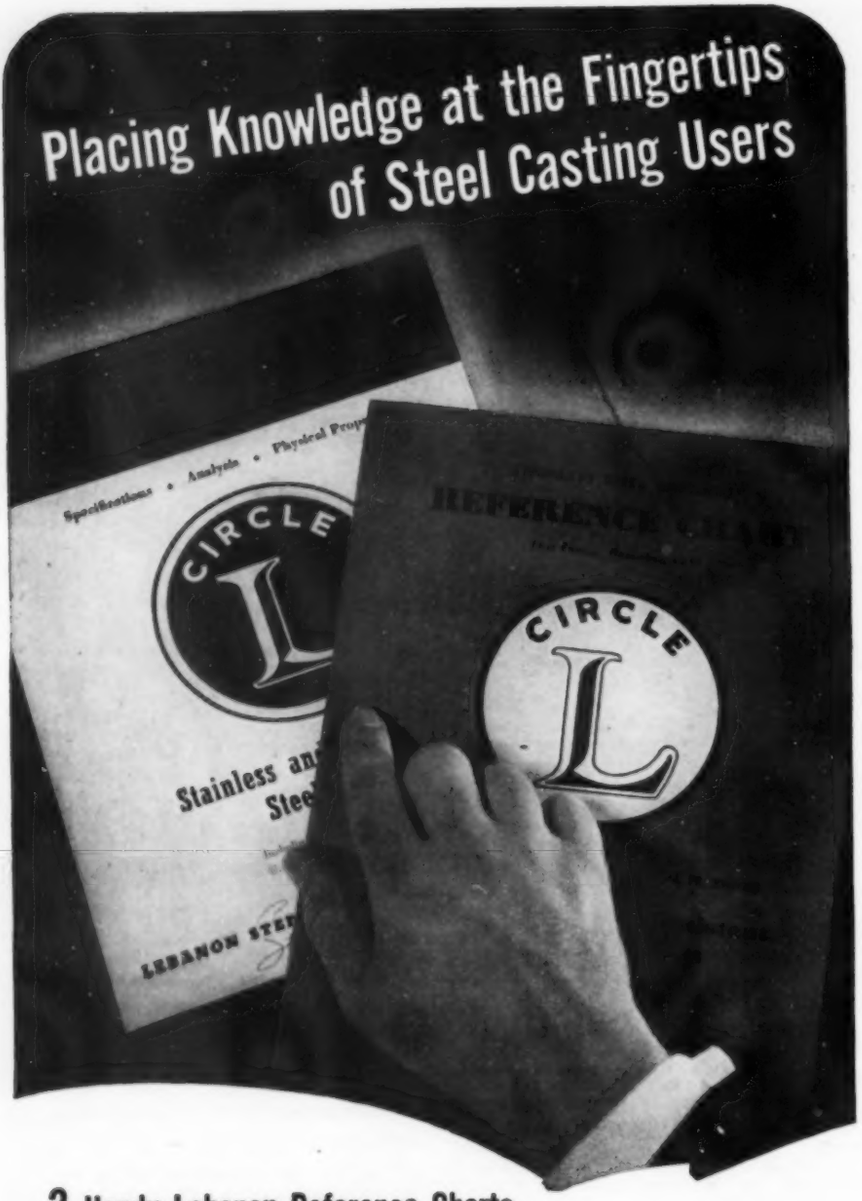

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931-G. Department of the Interior. Price, 50 cents.

Nickel Deposit near Riddle Douglas County, Oregon. Geological Survey Bulletin 931-I. Department of the Interior. Price, 20 cents.

Tin Deposits of Northern Lander County, Nevada. Geological Survey Bulletin 931-L. Department of the Interior. Price, 20 cents.

Alkalic Rocks of Iron Hill Gunnison County, Colorado. Geological Survey Professional Paper 197-A. Department of the Interior. Price, 40 cents.

United States Government Manual, Spring, 1942. Individual copies of this issue are 75 cents. Annual subscriptions with three editions a year are $2.75.

Federal Specifications Index, Revised to January 1, 1942. Procurement Division, Treasury Department. Price, 15 cents.

Annual Reports. The regular official reports of various departments and bureaus are now generally available in printed form. Those desiring complete review of the work of any such agency should request direct from the headquarters this annual document for the fiscal year ending June 30, 1941.

Manual for the Inspection of Aircraft Wood and Glue for the U. S. Navy, prepared by Forest Products Lab., Madison, Wisconsin: second edition. Price, $1.00.

Index and Specifications for Occupational Specialists. War Department, Army regulations 615-26. Price, 20 cents.

Censorship Rules. An unnumbered document dated February 17, 1942, issued by Bureau of Public Relations, War Department, entitled "Statement of War Department Policy Regarding Dissemination and Publication of Information Concerning Contracts, Production, Site Locations, Etc."

Priorities Orders in Force. Division of Information, Office for Emergency Management, War Production Board. An alphabetical listing of all priorities orders in the M, P, E, and L series, together with miscellaneous orders and regulations which have been issued under the priorities power, up to January 30.

Price Schedules in Force. Listing with complete text of orders from Office of Price Administration is made for all price schedules officially in force on February 11 in part II of Federal Register of February 21. This assembles in convenient form all previous issues officially published in the Federal Register. Price, 10 cents.

Alcohol Regulations. Preliminary printing of Regulations No. 3, Bureau of Internal Revenue, relating to industrial alcohol. Federal Register, Thursday, March 12. Price, 10 cents. Subsequently, a separate pamphlet will be issued by the Bureau.

Accident Experience at Pebble-Phosphate Operations in Florida 1930-40, by Frank E. Cash. Bureau of Mines Information Circular 7186; mimeographed.

Coal, Petroleum, Natural Gas, and Electricity in the United States, 1929-40, by John R. Bradley. Bureau of Mines Information Circular 7189; mimeographed.

Prevention of Premature Shots During Springing of Deep Drill Holes in Quarries and Open-Pit Workings. Bureau of Mines Information Circular 7191; mimeographed.

Regulations for the Enforcement of the Insecticide Act of 1910. U. S. Department of Agriculture, Agricultural Marketing Service. Service and Regulatory Announcements No. 162.

A Study of the Pollution and Natural Purification of the Scioto River. Federal Security Agency, U. S. Public Health Service. Public Health Bulletin No. 276. 20 cents.

Annual Report of the Tennessee Valley Authority 1941. Tennessee Valley Authority. 45 cents.

Statistics of Income for 1938, part 2. U. S. Treasury Department, Bureau of Internal Revenue. **35 cents.**

Volunteers in Health, Medical Care and Nursing. Office of Civilian Defense. 10 cents.

A Practical Seed-Cotton Moisture Tester for Use at Gins, by George E. Gaus, Charles S. Shaw, and Waldo H. Kliever. Department of Agriculture, Circular 621C; 26 pages. 10 cents.

MANUFACTURERS' LATEST PUBLICATIONS

Publications listed here are available from the manufacturers themselves, without cost unless a price is specifically mentioned. To limit the circulation of their literature to responsible engineers, production men and industrial executives, manufacturers usually specify that requests be made on business letterhead.

Ball Bearings. United Motors Service, Inc., General Motors Building, Detroit, Mich.—Form A58, booklet R—A new booklet which supersedes older editions and contains a listing of this concern's standard ball bearings, together with bearing numbers of other makes with which they will interchange.

Bearing Covers. R-S Products Corp., Wayne Junction, Philadelphia, Pa.—Bulletin 11A—4-page folder which describes briefly the various types of standard covers for ball and roller bearings put out by this concern. Includes information on the flat, medium and deep covers in both lug and round fastening flanges. Contains detailed drawings, dimension tables, and data on styles.

Belt Conveyor Idler. Continental Gin Co., Industrial Division, Birmingham, Ala. — Bulletin 1D103 — 4-page folder which illustrates and discusses briefly principles and applications of this concern's line of belt conveyor idlers. Contains a cross-sectional drawing showing the principles of operation, tables of dimensions, list prices and average weights.

Boiler Linings. The Ramtite Co., 2535 W. 18th St., Chicago, Ill.—6-page booklet entitled "Better Methods of Setting and Lining Return Tubular Boilers," which contains numerous illustrations and engineering drawings. Explains improvements in methods of setting and relining and discusses engineering properties of the concern's plastic refractories.

Castings. Hammond Brass Works, Hammond, Ind.—Handy data book of brass and bronze castings, giving standard specifications, applications and other related information on the complete line of brasses and bronze furnished by this concern. Also includes chemical analyses, physical properties, applications, data on bearings and microphotographs.

Centrifugal Fans. National Association of Fan Manufacturers, 5-208 General Motors Bldg., Detroit, Mich.—Form X-12—12-page folder which gives standard methods adopted for centrifugal fans and blowers. Contains extensive engineering tables on air density ratios at various altitudes and air temperatures, typical specifications, abrasion, field tests on fans, comparison charts and fan sizes for multi-blade and non-overloading fans.

Chemicals. International Minerals & Chemical Corp., 20 N. Wacker Drive, Chicago, Ill.—Vol. 1, No. 1 of "Min. & Met.", this concern's house organ which will be devoted to phosphate, potash and other related products of this concern.

Concrete. The Atlas Lummite Cement Co., 135 E. 42nd St., New York, N. Y.—16-page booklet which describes and illustrates use of this concern's "Lummite" cement in making concrete which has full working strength in less than 24 hours of placing.

Control Instruments. C. J. Tagliabue Mfg. Co., Park & Nostrand Ave., Brooklyn, N. Y.—Catalog 1101G—38-page catalog which treats of this concern's electric thermometers, pyrometers, recording potentiometers, indicating controllers, etc. Each unit is illustrated, described in detail, and advantages pointed out. Also contains specification charts and data on different models and their parts.

Control Instruments. Taylor Instrument Companies, Rochester, N. Y.—Catalog 36R—8-page catalog on this concern's self-acting temperature controller. Contains numerous application drawings and tables of engineering data on temperature ranges and sensitivity as well as valve information. Construction features are listed and briefly described.

Dust Collectors. American Foundry & Equipment Co., 555 S. Byrkit St., Mishawaka, Ind.—Catalog 72—58-page revised catalog describing this concern's "Dustube" dust collector, both knock-down and assembled types. Gives information to aid in the selection of proper control equipment for specific dust problems, provides information and photographs of models available with operating data, construction features and basic specifications of these cloth-bag type collectors. Also includes engineering and operating data, technical layouts and charts.

Electrical Equipment. H D Electric Co., 100 W. Monroe St., Chicago, Ill.—8-page folder which deals with this concern's meters for measuring demand on any transformer, electrical conductor or electrical circuit. Contains photographs of each unit, descriptive material on outstanding features and applications of the unit, as well as charts and tables of engineering data. Also contains a price list of the units and their accessories.

Engineering Data. Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.—36-page brooklet entitled "Revere Weights and Data Handbook" which gives extensive engineering tables on copper, brass and bronze products. Includes data on wire gages, equivalents, melting points and densities of metals, metric and English conversion tables, areas of circles, weight of sheet, roll and strip copper, brass and bronze alloys, etc.

Equipment. Carrier Corp., South Geddes St., Syracuse, N. Y.—Catalog AC152—12-page condensed catalog which covers the air conditioning, refrigeration and space heating equipment put out by this concern. Contains detailed specifications, brief descriptive material, dimensions and weights, capacity ratings, and photographs of the various units.

Equipment. The Elliott Co., Jeannette, Pa.—Bulletin H13—4-page bulletin with detailed information on this concern's two smallest frame sizes of mechanical drive turbines. Also bulletin YN10, 4 pages describing various tube cleaner equipment for cleaning of small tubes in condensers, heaters, heat exchangers, etc. Also bulletin A7, 24 pages on this concern's twin strainers, with descriptive matter, photographs, line cuts, tables of dimensions, etc.

Evaporative Condensers. The Carrier Corp., Syracuse, N. Y.—A series of three leaflets giving technical information on this concern's evaporative condensers. Describes equipment designed to supplant water-cooled condensers and water-cooled towers and refrigerative systems, and also to cool liquids in various industrial applications. Also describes a compound for treating the water used as spray to decrease scale formation and corrosion. Each unit is illustrated by a photograph and diagrammatic sketch.

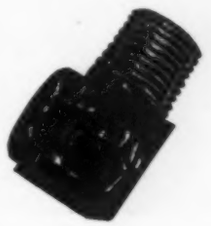
Fly Ash. Western Precipitation Corp., 1016 W. 9th St., Los Angeles, Calif.—24-page booklet entitled "Fly Ash Elimination" which gives information on collection of fly ash before it goes up the stack. Contains much valuable information on collection of fly ash, with graphs, diagrams, tables of collection efficiency, methods of preliminary tests and suggestions on procedure. Contains extensive engineering information in chart, table, and diagrammatic drawing form. Extensively illustrated by photographs.

Graphite. The United States Graphite Co., Saginaw, Mich.—12-page booklet which describes briefly and illustrates a few of the many uses of this concern's Mexican graphite. Also 12-page booklet

MONARCH

CHEMICAL SPRAY NOZZLES

of



BRASS:

The Fig. 629 nozzle illustrated is of the "non-clog" type; i.e. it contains no internal vanes, slots, or deflectors which might facilitate clogging.

Available ¼" or ⅜" male pipe connection and ¼" to 1" female pipe. (Fig. 631). Small sizes produce a very fine, soft, wide angle spray at low pressures. Capacities 4.7 G.P.H. up.

STONEWARE:

Monarch Fig. 6020 and Fig. 6040 stoneware sprays have replaced most other types of nozzles used in acid chamber plants throughout the world. Last almost indefinitely in sulfur gases and will not break or crack from temperature changes.

STAINLESS:

Available in capacities from .57 g.p.h. (Fig. F-80 style) to 104 G.P.M. (Fig. B-8-A style). "Hollow" cone, "Solid" cone, and "Flat" sprays furnished in pipe sizes and capacities and materials to suit practically any problem where corrosive liquids are sprayed.

Write for Catalogs 6A and 6C

Note: All metals are under priority, therefore (excepting for very small quantities from stock) preference ratings are required.

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Wind is fire's best friend—and the worst enemy of most foams! But National Foam is exceptionally *wind-resistant.* It settles down over a fire in a tough smothering blanket of bubbles that *stick!*

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Fire-Protection Specialists in the Chemical and Metallurgical Industries

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discussing the concern's molded graphite material trademarked "Graphitar" includes brief descriptive material on its use for bearings, pump blades, blocks, electrical contacts, molds, and seals.

Heat Engineering. C. O. Bartlett & Snow Co., Cleveland, Ohio—Revised edition of this concern's engineering catalog which describes the company's continuous rotary and batch dryers, calciners, coolers, rotary and batch kilns, autoclaves and related equipment. Contains a discussion of principles involved in drying and technical data relating to heat engineering.

Heat Exchangers. Niagara Blower Co., 6 E. 45th St., New York, N. Y.—Bulletin 90—4-page folder which describes briefly and illustrates this concern's "Aero" heat exchanger for controlling temperatures of lubricating or quenching oils, broaching or grinding oils, cooling water, etc. Contains a diagrammatic sketch of the unit.

Heat Transfer. The Girdler Corp., Votator Division, Louisville, Ky.—Booklet which describes this concern's mechanism for heating or cooling of liquids and viscous materials, simultaneously with mixing, emulsifying or aerating. Includes information on outstanding features of the mechanism, charts, diagrams, cross sections and reference tables.

Hydraulic Presses. Dominion Engineering Co., Ltd., Lachine, Que., Canada.—28-page catalog discussing briefly and illustrating extensively the uses of this concern's hydraulic presses for both peace-time and war-time purposes. Photographs show operating installations.

Industrial Products. Johns-Manville, 22 East 40th St., New York, N. Y.—Form G16A—52-page illustrated catalog dealing with this concern's complete line of industrial products. Contains information and recommendations on high and low temperature insulations for industrial needs, data on refractory products and castables, specifications on bonded asbestos built-up roof and insulated roof, as well as information on industrial friction materials, electrical materials, "Transite" pressure pipe, vent pipe and stacks, and packings and gaskets. Contains extensive illustrations and engineering data in table form.

Laboratory Instruments. The Emil Greiner Co., 161 Sixth Ave., New York, N. Y.—72-page catalog on this concern's new and improved laboratory apparatus and instruments of various types and sizes. Each unit is illustrated and described briefly. Contains specifications and prices for the unit as well as for its various accessories.

Machine Shops. Continental Machine, Inc., 1301 Washington Ave., South, Minneapolis, Minn.—1942 combination calendar and educational course in machine tools and machine shop practice in 12 lessons. Parts of the course are elementary for the benefit of apprentices. New information is given on "chip production" for all 11 basic types of machine tools. The calendar measures 40 inches by 22 inches.

Manometers. Trimont Instrument Co., 37 W. Van Buren St., Chicago, Ill.—8-page folder which deals with the various types of manometers, mercury pressure gages, indicating flow meters and liquid level indicators put out by this concern. Each unit is illustrated and briefly described.

Mineral Wool. Industrial Mineral Wool Institute, 411 Lexington Ave., New York, N. Y.—Specification Folder No. 1—8-page folder which gives general, material and application specifications for mineral wool in low temperature installations and also includes specifications for applying mineral wool on cold pipe lines. Includes considerable engineering data in the form of diagrammatic drawings, tables and text material.

Mixing. Chain Belt Co., 1600 W. Bruce St., Milwaukee, Wis.—Bulletin 389—6-page folder which describes, illustrates and gives technical information on this concern's "Rex Slo-Mixers" which offer the advantages of the Langlier process of multi-stage flocculation. Illustrates the use of these mixers in sewage and water treatment plants.

Paints. Tamms Silica Co., 228 N. La

Salle St., Chicago, Ill.—24-page catalog and price list of this concern's complete line of paints, sundries, and builders' supplies. It gives condensed information on such items as bleaches, casein paints, cleaners, concrete hardeners, plasters, sizers and sealers, etc.

Plastics. Catalin Corp., 1 Park Ave., New York, N. Y.—60-page illustrated booklet dealing with the fabrication of Catalin, this concern's cast phenolic resin. Gives data on advantages of the resin, physical and chemical properties, the technique of casting and molding, lathe and screw machine production, grinding, polishing, decoration and other aspects of fabrication.

Plywood. Durez Plastics & Chemicals, Inc., Walck Road, N. Tonawanda, N. Y.—4-page folder which illustrates and describes briefly the history, manufacture and uses of resin-bonded plywood. Also gives information on Durez resins used in the bonding of plywood.

Porcelain Molding. Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.—Leaflet E-3100—4-page leaflet which describes this concern's "Prestite," a porcelain for molding to intricate shapes for which electrical and mechanical properties must be high. Describes the material and its uses by a series of questions and answers. It is stated that Prestite is one of the few such materials for which no priority is necessary.

Pressure Recorders. The Foxboro Co., Foxboro, Mass. Catalog 22A—32-page catalog illustrating and describing this concern's line of pressure recorders, giving a complete list of standard ranges accompanied by full-size reproductions of specimen charts. Also describes methods of instrument mountings, types of cases available, integral electric signal systems, accessories, equipment, etc.

Priorities. Calco Chemical Division, American Cyanamid Co., Bound Brook, N. J.—Technical Bulletin No. 648—12-page bulletin entitled "The Priorities System as Related to the Chemical Industry." Contains helpful and timely information on the set-up of the Office of Emergency Management and the present War Production Board. Discusses the priorities system, preference, allocation and limitation orders, priority as determined by ultimate use, price control, and industry compliance. Also contains a six-page useful chart listing identification numbers of the orders issued by the War Production Board through Feb. 18, 1942, as well as numbers of the price schedules established by the Office of Price Administration up to that date.

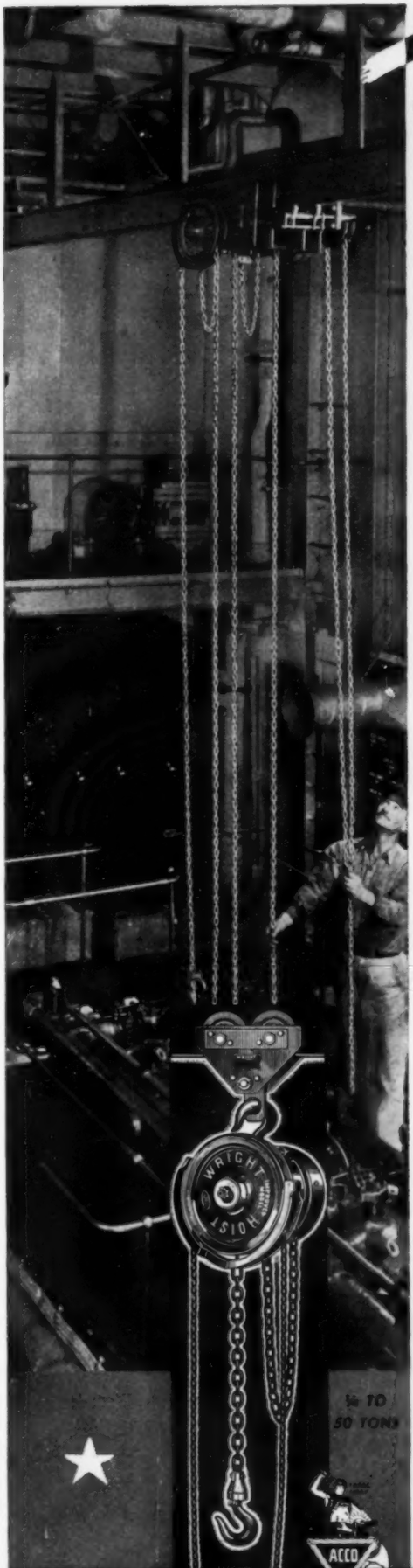
Pumps. Blackmer Pump Co., Grand Rapids, Mich.—Bulletin 110—4-page folder which illustrates and describes briefly this concern's direct-connected pumps of the rotary type. Contains cross-sectional drawings, construction details, selection charts and other engineering data.

Pumps. Warren Steam Pump Co., Inc., Warren, Mass.—20-page booklet on this concern's pumping machinery. Includes information on experience and facilities of the concern, specifications, service, and special construction features of the concern's line of centrifugal pumps of various types, liquid pumps, piston pumps, as well as plunger, vacuum and automatic pumps. Each unit is illustrated by photograph and cross-sectional drawings and engineering data are included in table form.

Respirators. H. F. Cover, Station A, South Bend, Ind.—2-page sheet which illustrates and describes briefly this concern's double-filter respirator, automatic sponge and cloth respirator, and gas-tight, fogproof rubber goggles. Includes a price list of the various items and their accessories.

Respirators. Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y.—18-page folder which deals with the safety appliances put out by this concern, including respirators of various types for protection against ordinary dusts, gases, smoke and fumes, dust hoods and helmets, heavy duty respirators, as well as equipment and protective clothing for the safe handling of acids and chemicals. Includes illustrations, specifications and prices.

Rubber Conservation. B. F. Goodrich



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• Wright load hooks are drop-forged from special steel which, when subjected to excessive overloading, gives visible warning by opening slowly. When the bottom hook has started to open, look to the top hook, too, for while it is stronger than the bottom hook, it also may be reaching a danger point.

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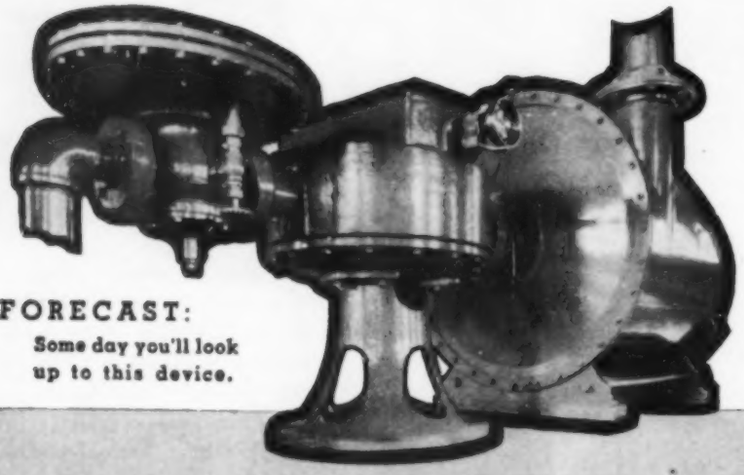

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The Industrial Carburetor is putting fast, economical gas heat *inside of solutions* instead of outside of the pot, provides efficient heat safely where open flames can not be used, supplies fuel to the economical, fully automatic Kemp Inert Gas Producer.

With the Industrial Carburetor, fuel savings over other heating equipment are normally from 15 to 40 percent, frequently higher. For engineering details and assistance address **The C. M. Kemp Manufacturing Co., 405 E. Oliver Street, Baltimore, Maryland.**

KEMP of BALTIMORE

Co., Akron, Ohio—Four pocket size folders on "How to Get the Most Service Out of Industrial Rubber Products." Subjects treated include "Transmission Belting," "Conveyor Belting," "V-Belt Drives" and "Belt Salvage." Each of the subjects is subdivided into chapters dealing with various angles of the topic and written in non-technical language for shop foremen or maintenance men. Extremely practical. Number of copies desired for distribution among plant and shop personnel should be stated in the letter of request.

Speed Indicator. Reeves Pulley Co., Columbus, Ind.—Bulletin G 427—4-page folder which illustrates and describes this concern's newly developed electric remote speed indicator for use with variable speed control equipment and designed to increase the utility of the drives put out by the company.

Temperature Measurement. Wheelco Instruments Co., Harrison and Peoria Sts., Chicago, Ill.—Defense Bulletin 1—6-page folder entitled "Priorities and Pyrometers" intended to explain to users of temperature measuring and control instruments how the national defense program affects these instruments, their purchase, use, maintenance and the replacement necessary. Suggests substitute materials, compares properties of original and substitute materials, and gives hints on how to maintain present equipment in order to operate with maximum efficiency and uninterrupted service.

Spray Equipment. Eclipse Air Brush Co., Inc., 390 Park Ave., Newark, N. J.—Catalog 80—32-page booklet covering this concern's complete line of spray equipment for both manual and automatic operation, as well as air-motored agitators for batch mixing jobs. Explains the low pressure principle of the concern's line of spray equipment. Illustrated with photographs of equipment in operation.

Speed Control. Reeves Pulley Co., Columbus, Ind.—Bulletin G423—16-page booklet entitled "More Output for Defense" which illustrates and describes uses and applications of this concern's variable speed control equipment in defense industries and on different type machines. Contains brief descriptive material and extensive installation photographs.

Steam Traps. Sarco Co., Inc., 475 Fifth Ave., New York, N. Y.—Bulletin 450—7-page bulletin dealing with this concern's float-thermostatic steam traps, compressed air traps and liquid level controls. Each unit is illustrated, discussed briefly, and shown in a diagrammatic drawing. Includes information on dimensions, list prices, capacities, and principles of installation.

Steel. Joseph P. Ryerson & Son, Inc., Cleveland, Ohio—List 1942-43—268-page steel stock list commemorating the 100th anniversary of this concern. Lists more than 11,000 different kinds, sizes and shapes of steel bars, sheets, plates, shapes, etc., and also contains a brief history of the growth of the organization.

Strontium in Ceramics. Foote Mineral Co., 16th and Summer Sts., Philadelphia, Pa.—12-page technical article in this concern's house organ which deals with the possibilities of strontia in ceramics, usually in conjunction with barium or calcium. Includes comparisons of the effects of different alkaline earths in glass and ceramics, tabulated data from various sources on the effects of strontia in ceramics, and a useful bibliography on the subject. Well illustrated by photographs and graphs.

Transmission. Ideal Commutator Dresser Co., Sycamore, Ill.—52-page handbook on the line of variable speed pulleys, transmissions, and automatic tension control motor base put out by this concern. Gives application data, recommendations, sizes, rated capacities, design and operating details, methods of installation, and other engineering information.

Wire Rope. Macwhyte Co., Kenosha, Wis.—Vol. 1, No. 1 of this concern's new house organ entitled "Ropeology" which will be designed to help wire rope users on such problems as proper selection of wire rope, conservation of rope, rust removal, lubrication, etc.

CONVERSION OF PLANTS FROM CIVILIAN TO WAR-TIME GOODS HAS LITTLE EFFECT ON DEMAND FOR CHEMICALS

CHEM & MET ECONOMICS & MARKETS

While considerable progress has been reported in the conversion of plants from civilian goods to products essential for the conduct of the war, the effect on the movement of chemicals is very minor. There is so much outside of munitions and equipment which is necessary to the war effort that production in some lines is of record proportions due only in part to direct war demands. For instance, in recent months, outputs of glass containers have been unusually high not only because of the larger quantities of goods packaged but also because scarcity of other containers placed extra burdens on glass plants. On the other hand rubber mills offer an example of a slowing up in demand for chemicals although no figures are available to point out definitely just how large this decline has been. Despite the curtailment of chlorine in the pulp and paper industry, these mills are operating at a high rate and their consumption of chemicals is correspondingly high. Runs of crude petroleum to stills have been reduced and the immediate outlook is clouded by uncertainties about the ability to move stocks regularly from refineries but some of the refining operations are taking more chemicals relatively than was the case in recent years. Government requirements for paints have been running to large totals but producers have been forced to make adjustments in the materials used as some materials are under controls which prescribe total industry use.

The effects of plant conversions and control over chemical deliveries are noted in a few cases in the way of freer offerings of some of the hitherto scarce chemicals. In general, however, demand for materials has increased to a point where no accumulations of stocks are possible. This again may be illustrated by reference to the glass industry. The decline in use of plate glass following the cut in automotive output means that less soda ash will be required this year in making plate glass. Assuming that plate glass plants consumed 60,000 tons of ash last year and will take only one-half that amount in 1942, a surplus of 30,000 tons would be released for other purposes. But the rising outturn of aluminum will require an increase in ash consumption of far more than 30,000 tons and a survey of other industries which are large users of ash indicates that declines in some directions will be much more than offset by increased demands from the majority of consuming branches. What is true of soda ash applies with equal force to most of the important tonnage chemicals.

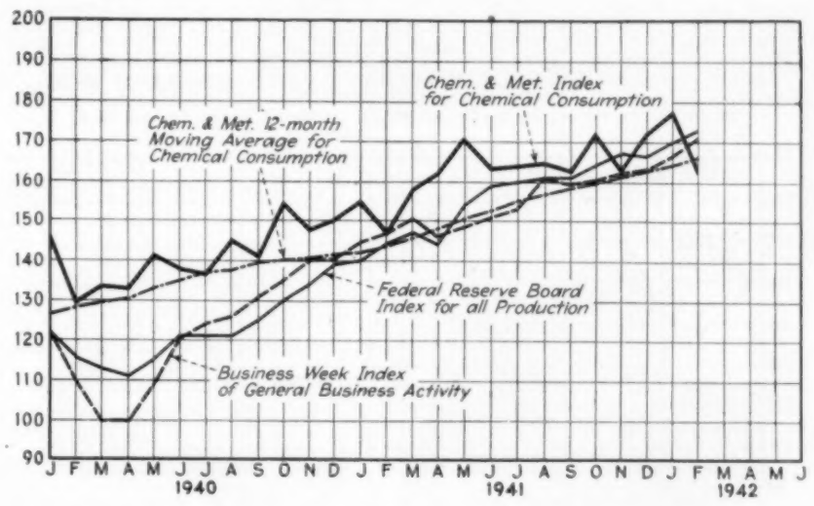
Consumption of commodities as indicated by prospective railroad freight traffic for the second quarter is estimated by the Shippers Advisory Boards at 14.6 percent above actual loadings for the second quarter of 1941. This average was reached after allowance for sharp losses in the movement of agricultural implements and vehicles other than automobiles. Percentage gains for some of the commodity groups as estimated are: coal and coke, 31.1; citrus fruits, 17.5; grain, 17.4; gravel, sand and stone, 17.2; chemicals and explosives, 16.3; and cotton, 12.7.

Chem. & Met. Index for Industrial Consumption of Chemicals

(1935 equals 100)

	Jan.	Feb.
Fertilizer	37.91	35.72
Pulp and Paper	23.30	21.30
Petroleum refining	15.57	13.19
Glass	16.60	15.18
Paint and varnish	15.28	14.67
Iron and steel	13.45	12.05
Rayon	15.10	12.84
Textiles	12.07	11.35
Coal products	9.78	8.74
Leather	5.30	5.02
Industrial explosives	5.36	5.49
Rubber	3.00	3.00
Plastics	4.40	4.35
	177.12	162.90

The movement of chemicals into consumption in February was considerably lower than it was in the preceding month with the smaller number of working days having much to do with the decline. It is noted however that in some cases the drop was due to lower operating rates on the part of consuming industries. The index for February is 162.90 compared with a revised figure of 177.12 for January. In 1941 the index numbers were 148.81 and 155.01 respectively. Latest figures indicate a very high daily rate for consumption of cotton but the use of wool and rayon has not kept pace with that reported a short time ago.

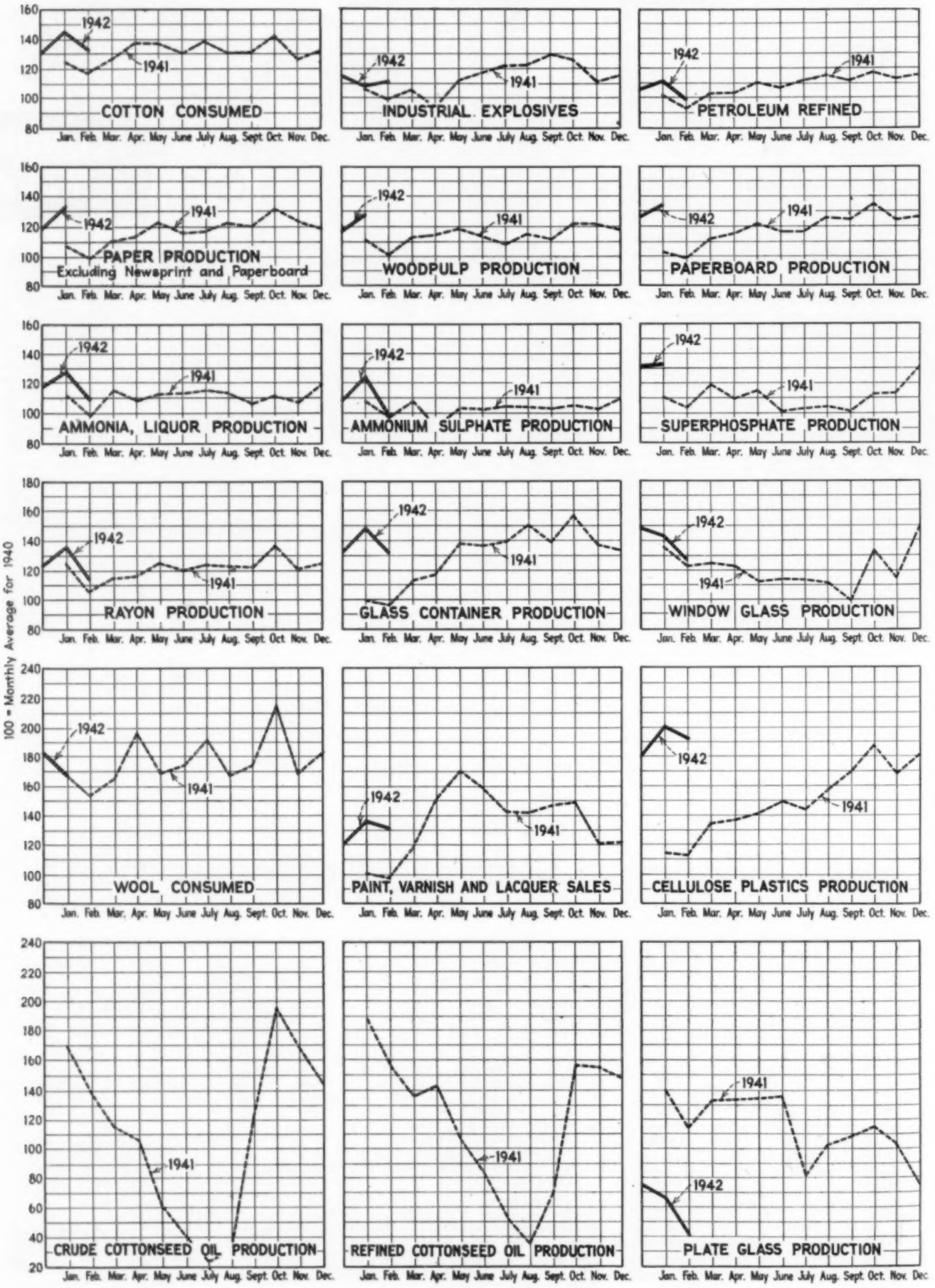


Production and Consumption Data for Chemical-Consuming Industries

	Feb. 1942	Feb. 1941	Jan.-Feb. 1942	Jan.-Feb. 1941	Percent of gain for 1942
Production					
Ammonia, liquor, 1,000 lb.[1]	5,209	4,682	11,018	10,009	10.1
Ammonium sulphate, tons[1]	58,598	58,360	124,146	123,029	0.09
Byproduct coke, 1,000 tons	4,716	4,502	9,939	9,435	5.3
Toluol, 1,000 gal.[1]	2,478	2,122	5,097	4,503	13.2
Naphthalene, 1,000 lb.[1]	6,291	5,728	13,377	12,464	7.3
Phenol, 1,000 gal.[1]	819	726	1,680	1,667	0.08
Glass containers, 1,000 gr.	5,965	4,368	12,720	8,885	43.2
Plate glass, 1,000 sq. ft.	5,600	15,554	14,743	35,014	57.9*
Window glass, 1,000 boxes	1,457	1,397	3,095	2,958	4.6
Cellulose acetate plastics, 1,000 lb.					
Sheets, rods, and tubes	567	344	1,152	960	20.0
Molding composition	3,789	1,879	7,267	3,510	104.2
Nitrocellulose plastics, 1,000 lb.	1,377	1,132	2,994	2,299	30.2
Pyroxylin spread, 1,000 lb.	5,473	6,262	11,515	12,256	6.0*
Consumption					
Cotton, bales	893,745	793,428	1,839,654	1,638,267	12.3
Cottonseed oil, bbl.	254,778	298,781	531,816	668,244	20.4*
Explosives, 1,000	37,681	33,631	74,401	69,711	6.7
Paint, Varnish, sales, $1,000	45,176	33,691	92,220	68,295	35.0

* Percent of decline. [1] Production at byproduct coke plants.

Production and Consumption Trends



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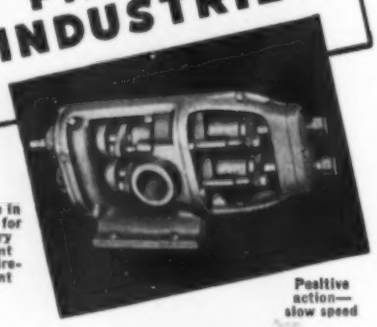

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Bump Pumps do not depend upon excessive speed for constant and positive delivery. They will handle thin or viscous liquids under pressures and vacuums, and liquids with temperatures up to 210° can be successfully handled by all standard models. Stainless steel construction—nickel alloy, bronze or iron. Also made in pulley models and gear driven. No agitation—Large internal chambers—long sealing surfaces—practical and very economical for pumping.

The BUMP PUMP CO.
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NEW GOVERNMENT REGULATIONS AFFECT DISTRIBUTION OF DYES, CHEMICALS, AND VEGETABLE OILS

As DEMAND for essential finished products increases, distribution of raw materials comes under greater and greater control. One of the important regulations of last month is concerned with dyestuffs which are necessary for manufacture of uniforms. A conservation order, effective on March 28, provides that ten dyes with colors ranging from orange and yellow to brown, khaki and olive drab be set aside entirely for war use. Civilian use of all other anthraquinone vat dyes and other derivative dyes is limited for the second quarter of the year to 12½ percent of the amount used last year. The order further provides that no producer may export more than 8 percent of his total dyes requiring anthraquinone in their manufacture. The order does not materially change the amount of chemicals consumed in dyes but diverts a certain amount of dyes from civilian to military use.

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Curtailment of shellac supplies has placed a premium on spot holdings and civilian uses will be limited, in order to insure adequate supplies for military needs. Some changes were made in the order regulating shipments of methyl alcohol. Where the methyl alcohol is to be used in the manufacture of formaldehyde for uses in Classification 1 of the original order, the preference rating has been raised to B-2. A preference rating of B-3 was given to embalmers but the amount of formaldehyde is still limited to one-fourth that used in 1940.

Operational changes in the original order also have been announced for molasses. The changes include a quota of 110 percent of their consumption for the year ending June 30, 1941, to manufacturers of yeast, citric acid and vinegar and users of molasses for foundry purposes.

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Restrictions on uses for vegetable oils also were increased during the month. Because of the current importance of glycerine, all oils with a high lauric acid content are prohibited in the manufacture of margarine, shortening or cooking fat. Also no processor may saponify more than 75 percent of his average use of these oils or fatty acids derived from these oils, for saponification in 1941. Coconut, babassu, palm-kernel oils are specifically mentioned and the order prohibits any use of them which does not product glycerine or in which the amount of glycerine remaining in the product exceeds 1.5 percent on an anhydrous soap basis. With imports of palm oil eliminated, stocks are limited to use in manufacture of tin plate, terne plate, long terne plate, steel sheets, steel strip and black plate. It likewise may be used in any manufacturing process where glycerine is produced and where the amount of glycerine remaining in the product does not exceed 1.5 percent. Rapeseed oil, after April 1, is reserved for war needs. It can now be used only in the manufacture of marine engine oils, heavy machine lubricating oils, pneumatic tool oils, blown rapeseed oil and elastic solids for compounding rubber.

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Base=100 for 1937

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Weighted Index of Prices for

OILS & FATS

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Bulletin No. 206 describes these furnaces and will be sent upon request.

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In many industries quality built

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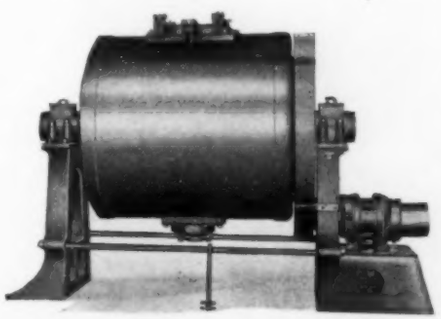
BALL AND PEBBLE MILLS

are operating night and day, without let up to speed up Victory production.

Economical too, because no labor is required during milling or mixing operations.



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WITHOUT { HAMMERS PLATES BURRS ROLLS or SIEVES

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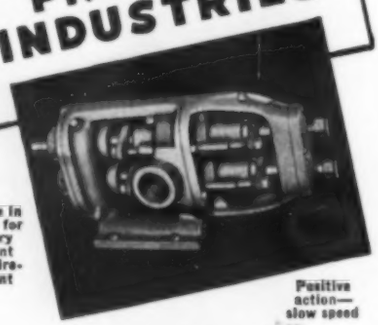

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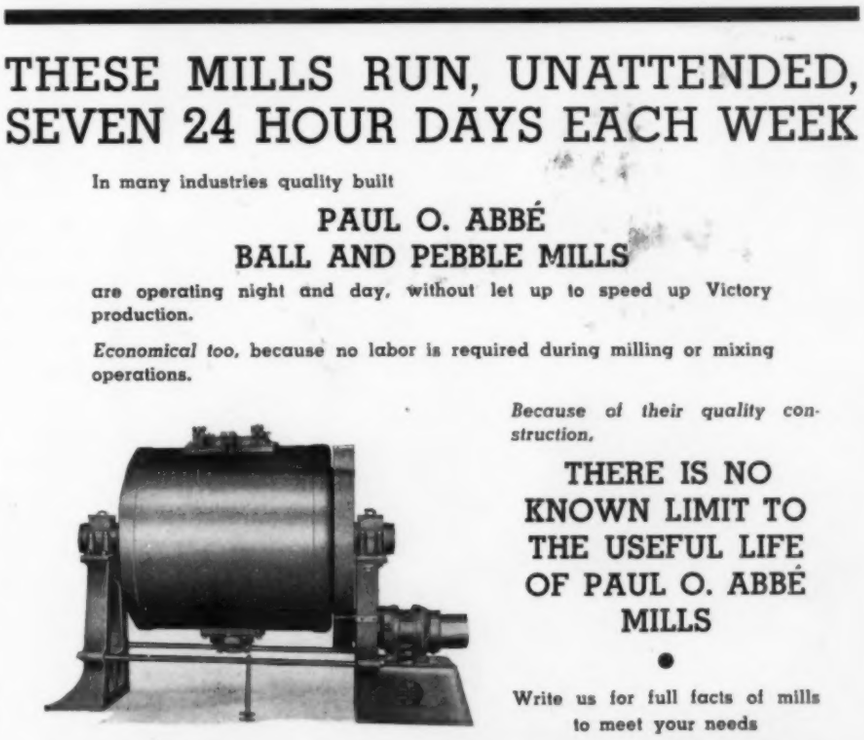
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Know What's UNDER the Trade-mark Before You Buy MOTORS!

PROUD as we are of the Fairbanks-Morse trade-mark, we urge that before buying you look beyond the trade-mark—*look at the motor.* For we know, and you know, that it's the motor and not the trade-mark that runs machines.

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DIESEL ENGINES ELECTRICAL MACHINERY MAGNETOS RAILROAD EQUIPMENT WASHERS-IRONERS STOKERS
PUMPS MOTORS FAIRBANKS SCALES WATER SYSTEMS FARM EQUIPMENT AIR CONDITIONERS

CHEM & MET CURRENT PRICES

INDUSTRIAL CHEMICALS

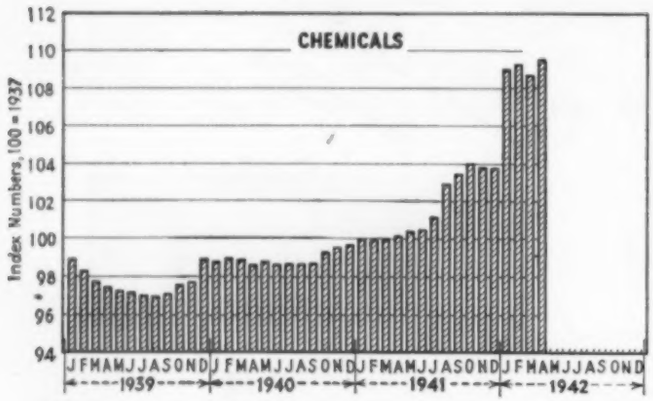
	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.168–$0.173	$0.168– $.173	$0.07½–$0.08
Acid, acetic, 28%, bbl., cwt	3.38 – 3.63	3.38 – 3.63	2.23 – 2.48
Glacial 99.5%, drums	9.15 – 9.40	9.15 – 9.40	8.43 – 8.68
U. S. P. X 1, 99.5%, dr	10.95 –11.20	10.95 –11.20	10.25 –10.50
Boric, bbl., ton	108.00–113.00	108.00–113.00	106.00–111.00
Citric, kegs, lb	.20 – .23	.20 – .23	.20 – .23
Formic, cbys., lb	.10½– .11	.10½– .11	.10½– .11
Gallic, tech., bbl., lb	1.10 – 1.15	1.10 – 1.15	.90 – 1.00
Hydrofluoric 30% drums, lb	.08 – .08½	.08 – .08½	.08 – .08½
Lactic, 44%, tech., light, bbl., lb	.073– .075	.073– .075	.06½– .06¾
Muriatic, 18°, tanks, cwt	1.05 –	1.05 –	1.05 –
Nitric, 36°, carboys, lb	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –	18.50 –20.00
Oxalic, crystals, bbl., lb	.11½– .13	.11½– .13	.10½– .12
Phosphoric, tech., c'bys., lb	.07½– .08½	.07½– .08½	.07½– .08½
Sulphuric, 60°, tanks, ton	13.00 –	13.00 –	13.00 –
Sulphuric, 66°, tanks, ton	16.50 –	16.50 –	16.50 –
Tannic, tech., bbl., lb	.71 – .73	.71 – .73	.54 – .56
Tartaric, powd., bbl., lb	.70 –	.70 –	.63 –
Tungstic, bbl., lb	nom	nom	nom
Alcohol, amyl			
From Pentane, tanks, lb	.131–	.131–	.111–
Alcohol, Butyl, tanks, lb	.158–	.158–	.09 –
Alcohol, Ethyl, 190 p'f., bbl., gal	8.19 – 8.25	8.19 – 8.25	6.04 –
Denatured, 190 proof			
No. 1 special, dr., gal. wks	.60 –	.60 –	.32 –
Alum, ammonia, lump, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Potash, lump, bbl., lb	.04 – .04½	.04 – .04½	.03½– .04
Aluminum sulphate, com. bags, cwt	1.15 – 1.40	1.15 – 1.40	1.15 – 1.40
Iron free, bg., cwt	1.85 – 2.10	1.85 – 2.10	1.60 – 1.70
Aqua ammonia, 26°, drums, lb	.02½– .03	.02½– .03	.02½– .03
tanks, lb	.02 – .02½	.02 – .02½	.02 – .02½
Ammonia, anhydrous, cyl., lb	.16 –	.16 –	.16 –
tanks, lb	.04½–	.04½–	.04½–
Ammonium carbonate, powd. tech., casks, lb	.09½– .12	.09 – .12	.09 – .12
Sulphate, wks., cwt	1.45 –	1.45 –	1.45 –
Amylacetate tech., from pentane, tanks, lb	.145–	.145–	.105–
Antimony Oxide, bbl., lb	.15 –	.15 –	.12–
Arsenic, white, powd., bbl., lb	.04 – .04½	.04 – .04½	.03½– .04
Red, powd., kegs, lb	nom	nom	nom
Barium carbonate, bbl., ton	60.00 –65.00	60.00 –65.00	52.50 –57.50
Chloride, bbl., ton	79.00 –81.00	79.00 –81.00	79.00 –81.00
Nitrate, casks, lb	.10½– .11	.10½– .11	.08½– .10
Blanc fix, dry, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt	2.25 – 2.35	2.25 – 2.35	2.00 – 2.10
Borax, gran., bags, ton	44.00 –	44.00 –	43.00 –
Bromine, cs., lb	.30 – .32	.30 – .32	.30 – .32
Calcium acetate, bags	3.00 –	3.00 –	1.90 –
Arsenate, dr., lb	.07 – .08	.07 – .08	.06½– .06¾
Carbide drums, lb	.04½– .05	.04½– .05	.04½– .05
Chloride, fused, dr., del., ton	19.00 –24.50	19.00 –24.50	19.00 –24.50
flake, dr., del., ton	20.50 –25.00	20.50 –25.00	20.50 –25.00
Phosphate, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb	.05½–	.05½–	.05 –
Tetrachloride drums, gal	.73 – .80	.73 – .80	.66½– .73
Chlorine, liquid, tanks, wks., lb	2.00 –	2.00 –	1.75 –
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb	1.84 – 1.87	1.84 – 1.87	1.84 – 1.87
Copperas, bgs., f.o.b., wks., ton	18.00 –19.00	18.00 –19.00	18.00 –19.00
Copper carbonate, bbl., lb	.18 – .20	.18 – .20	.10 – .16
Sulphate, bbl., cwt	5.15 – 5.40	5.15 – 5.40	4.75 – 5.00
Cream of tartar, bbl., lb	.57 –	.57 –	.52 –
Diethylene glycol, dr., lb	.14 – .15½	.14 – .15½	.22 – .23
Epsom salt, dom., tech., bbl., cwt	1.90 – 2.00	1.90 – 2.00	1.80 – 2.00
Ethyl acetate, drums, lb	.12–	.12 –	.07½–
Formaldehyde, 40%, bbl., lb	.05½– .06	.05½– .06½	.05½– .06
Furfural, tanks, lb	.09 –	.09 –	.09 –
Fusel oil, drums, lb	.18 – .19	.18 – .19	.16 – .17
Glaubers salt, bags, cwt	1.05 – 1.10	1.05 – 1.10	.95 – 1.00
Glycerine, c.p., drums, extra, lb	.18½–	.18½–	.12½–
Lead:			
White, basic carbonate, dry casks, lb	.08½–	.08½–	.07½–
White, basic sulphate, sck., lb	.07½–	.07½–	.07 –
Red, dry, sck., lb	.09½– .09¾	.09¾–	.0835–
Lead acetate, white crys., bbl., lb	.12½– .13	.12 – .13	.11 – .12
Lead arsenate, powd., bag, lb	.11 – .12	.11 – .12	.09½– .11
Lime, chem., bulk, ton	8.50 –	8.50 –	8.50 –
Litharge, pwd., csk., lb	.08½–	.08½–	.0735–
Lithopone, bags, lb	.04½– .04¾	.04½– .04¾	.038– .04
Magnesium carb., tech., bags, lb	.06½– .06¾	.06½– .06¾	.06½– .06¾
Menthanol, 95%, tanks, gal	.60 –	.60 –	.29 –
97%, tanks, gal	.60 –	.60 –	.30 –
Synthetic, tanks, gal	.28 –	.28 –	.30 –
Nickel salt, double, bbl., lb	.13½– .13¾	.13½– .13¾	.13½–
Orange mineral, csk., lb	.12½–	.12½–	.11½–
Phosphorus, red, cases, lb	.40 – .42	.40 – .42	.40 – .42
Yellow, cases, lb	.18 – .25	.18 – .25	.18 – .25
Potassium bichromate, casks, lb	.09½– .10	.09½– .10	.08½– .09
Carbonate, 80–85%, calc. csk., lb	.06½– .07	.06½– .07	.06½– .07
Chlorate, powd., lb	.10 – .12	.10 – .12	.10 – .12
Hydroxide (c'stic potash) dr., lb	.07 – .07½	.07 – .07½	.07 – .07½
Muriate, 60% bags, unit	.53½–	.53½–	.53½–
Nitrate, bbl., lb	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb	.19½– .20	.19½– .20	.19½– .20
Prussiate, yellow, casks, lb	.17 – .18	.17 – .18	.15 – .16
Sal ammoniac, white, casks, lb	.0515– .06	.0515– .06	.0515– .06
Salsoda, bbl., cwt	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	17.00 –	17.00 –	17.00 –
Soda ash, light, 58%, bags, contract, cwt	1.05 –	1.05 –	1.05 –
Dense, bags, cwt	1.10 –	1.10 –	1.10 –
Soda, caustic, 76%, solid, drums, cwt	2.30 – 3.00	2.30 – 3.00	2.30 – 3.00
Acetate, del., bbl., lb	.04½– .06	.04½– .06	.04 – .05
Bicarbonate, bbl., cwt	1.70 – 2.00	1.70 – 2.00	1.70 – 2.00
Bichromate, casks, lb	.07½– .08	.07½– .08	.06½– .07
Bisulphate, bulk, ton	16.00 –17.00	16.00 –17.00	16.00 –17.00
Bisulphite, bbl., lb	.03 – .04	.03 – .04	.03 – .04
Chlorate, kegs, lb	.06½– .06½	.06½– .06½	.06½– .06¾
Cyanide, cases, dom., lb	.14 – .15	.14 – .15	.14 – .15
Fluoride, bbl., lb	.08 – .09	.08 – .09	.07 – .08
Hyposulphite, bbl., cwt	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt	2.50 – 2.65	2.50 – 2.65	2.35 – 2.40
Nitrate, bulk, cwt	1.35 –	1.35 –	1.45 –
Nitrite, casks, lb	.06½– .07	.06½– .07	.06½– .07
Phosphate, tribasic, bags, lb	2.70 –	2.70 –	2.35 –
Prussiate, yel. drums, lb	.10½– .11	.10½– .11	.10½– .11
Silicate (40° dr.), wks., cwt	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr. lb	.03 – .03½	.03 – .03½	.02½– .03
Sulphite, crys., bbl., lb	.02½– .02¾	.02½– .02¾	.02½– .02¾
Sulphur, crude at mine, bulk, ton	16.00 –	16.00 –	16.00 –
Chloride, dr., lb	.03 – .04	.03 – .04	.03 – .04
Dioxide, cyl., lb	.07 – .08	.07 – .08	.07 – .07½
Flour, bag, cwt	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb	.55 –	.55 –	.54 –
Crystals, bbl., lb	.39½–	.39½–	.39 –
Zinc, chloride, gran., bbl., lb	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb	.14 – .15	.14 – .15	.14 – .15
Cyanide, dr., lb	.33 – .35	.33 – .35	.33 – .35
Dust, bbl., lb	.09½–	.09½–	.09½–
Zinc oxide, lead free, bag, lb	.07½–	.07½–	.06½–
5% leaded, bags, lb	.07½–	.06½–	.06½–
Sulphate, bbl., cwt	3.85 – 4.00	3.40 – 3.50	3.15 – 3.25

OILS AND FATS

	Current Price	Last Month	Last Year
Castor oil, 3 bbl., lb	$0.13¼–$0.14½	$0.13½–$0.14½	$0.10½–$0.11
Chinawood oil, bbl., lb	.38 –	.38 –	.29 –
Coconut oil, Ceylon, tank, N. Y., lb	nom	nom	.05½–
Corn oil crude, tanks (f.o.b. mill), lb	.12½–	.12½–	.08 –
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.12½–	.12½–	.07½–
Linseed oil, raw car lots, bbl., lb	.141–	.125–	.105–
Palm, casks, lb	.09 –	.09 –	.05 –
Peanut oil, crude, tanks (mill), lb	.13 –	.13 –	.06 –
Rapeseed oil, refined, bbl., lb	nom	nom	.13½–
Soya bean, tank, lb	.11½–	.11½–	.07½–
Sulphur (olive foots), bbl., lb	.19½–	.19 –	.12½–
Cod, Newfoundland, bbl., gal	nom	nom	nom
Menhaden, tight pressed, bbl., lb	.114–	.112–	.09 –
Crude, tanks (f.o.b. factory) gal	.66 –	.66 –	.44 –
Grease, yellow, loose, lb	.09295–	.09295–	.06½–
Oleo stearine, lb	.09½–	.09½–	.08 –
Oleo oil, No. 1	.11½–	.11½–	.08½–
Red oil, distilled, dp.p. bbl., lb	.12 –	.12 –	.06 –
Tallow extra, loose, lb	.097125–	.097125–	.07 –

The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to April 13

Chem. & Met.'s Weighted Price Indexes


CHEMICALS
Index Numbers, 100 = 1937
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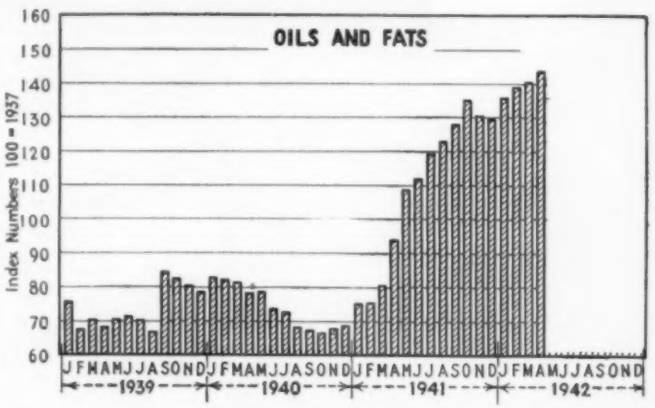
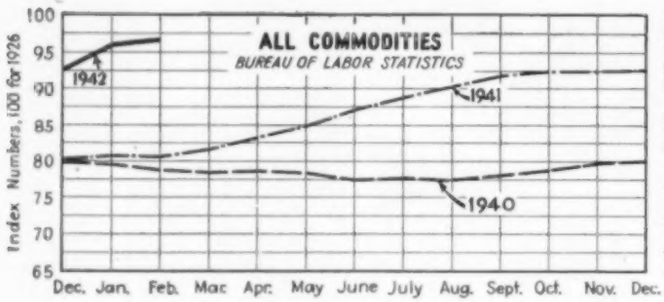
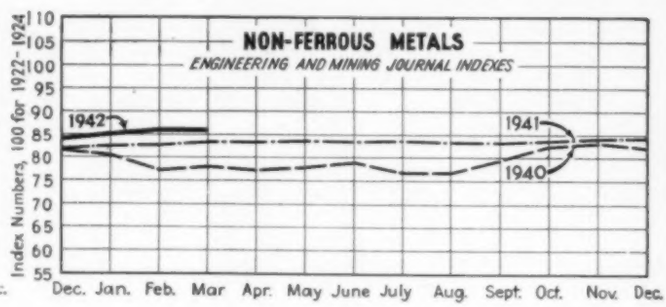






Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb.	$0.52 -$0.55	$0.52 -$0.55	$0.52 -$0.55
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.15 - .16	.15 - .16	.15 - .16
Aniline, salts, bbl., lb.	.22 - .24	.22 - .24	.22 - .24
Benzaldehyde, U.S.P., dr., lb.	.85 - .95	.85 - .95	.85 - .95
Benzidine base, bbl., lb.	.70 - .75	.70 - .75	.70 - .75
Benzoic acid, U.S.P., kgs., lb.	.54 - .56	.54 - .56	.54 - .56
Benzyl chloride, tech., dr., lb.	.23 - .25	.23 - .25	.23 - .25
Benzol, 90%, tanks, works, gal.	.15 -.....	.15 -.....	.14 -.....
Beta-naphthol, tech., drums, lb.	.23 - .24	.23 - .24	.23 - .24
Cresol, U.S.P., dr., lb.	.11 -.....	.11 - .11	.09½- .10
Cresylic acid, dr., wks., gal.	.81 - .83	.81 - .83	.58 - .60
Diethylaniline, dr., lb.	.40 - .45	.40 - .45	.40 - .45
Dinitrophenol, bbl., lb.	.23 - .25	.23 - .25	.23 - .25
Dinitrotoluol, bbl., lb.	.18 - .19	.18 - .19	.15½- .16
Dip oil, 15%, dr., gal.	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, dr. f.o.b. wks., lb.	.60 -.....	.60 -.....	.....
H-acid, bbl., lb.	.45 - .50	.45 - .55	.45 - .50
Naphthalene, flake, bbl., lb.	.07 - .07½	.07 - .07½	.07 - .07½
Nitrobenzene, dr., lb.	.08 - .09	.08 - .09	.08 - .09
Para-nitraniline, bbl., lb.	.47 - .49	.47 - .49	.47 - .49
Phenol, U.S.P., drums, lb.	.13 -.....	.13 -.....	.12 -.....
Picric acid, bbl., lb.	.35 - .40	.35 - .40	.35 - .40
Pyridine, dr., gal.	1.70 - 1.80	1.70 - 1.80	1.70 - 1.80
Resorcinol, tech., kegs, lb.	.75 - .80	.75 - .80	.75 - .80
Salicylic acid, tech., bbl., lb.	.33 - .40	.33 - .40	.33 - .40
Solvent naptha, w.w., tanks, gal.	.27 -.....	.27 -.....	.27 -.....
Tolidine, bbl., lb.	.86 - .88	.86 - .88	.86 - .88
Toluol, drums, works, gal.	.33 -.....	.33 -.....	.30 -.....
Xylol, com, tanks, gal.	.26 -.....	.26 -.....	.26 -.....

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech, bbl., lb.	.19½- .25	.19½- .25	.12½- .13
China clay, dom., f.o.b. mine, ton.	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors			
Carbon gas, black (wks.), lb.	.0335- .30	.0335- .30	.028- .30
Prussian blue, bbl., lb.	.36 - .37	.36 - .37	.36 - .37
Ultramarine blue, bbl., lb.	.11 - .26	.11 - .26	.10 - .26
Chrome green, bbl., lb.	.21½- .30	.21½- .30	.21 - .27
Carmine, red, tins, lb.	4.60 - 4.75	4.60 - 4.75	4.85 - 5.00
Para toner, lb.	.75 - .80	.75 - .80	.75 - .80
Vermilion, English, bbl., lb.	3.05 - 3.10	3.05 - 3.10	3.12 - 3.20
Chrome yellow, C.P., bbl., lb.	.14½- .15½	.14½- .15½	.14½- .15½
Feldspar, No. 1 (f.o.b.N.C.), ton.	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.08 - .10	.08 - .10	.06 - .06½
Gum copal Congo, bags, lb.	.09 - .30	.09 - .30	.06 - .30
Manila, bags, lb.	.09 - .15	.09 - .14	.09 - .14
Damar, Batavia, cases, lb.	.10 - .22	.10 - .20	.08 - .24
Kauri, cases, lb.	.18 - .60	.18 - .60	.18½- .60
Kieselguhr (f.o.b. mines), ton.	7.00 -40.00	7.00 -40.00	7.00 -40.00
Magnesite, calc, ton.	64.00 -.....	65.00 -.....	65.00 -.....
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	nom	nom	.03 - .04
Rosin, H., 100 lb.	3.44 -.....	3.83 -.....	2.58 -.....
Turpentine, gal.	.70½-.....	.80½-.....	.49-.....
Shellac, orange, fine, bags, lb.	.43 -.....	.43 -.....	.27 -.....
Bleached, bonedry, bags, lb.	.40 -.....	.40 -.....	.28 -.....
T. N. Bags, lb.	.32 -.....	.32 -.....	.20 -.....
Soapstone (f.o.b. Vt.), bags, ton.	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc. 200 mesh (f.o.b. Vt.), ton.	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
200 mesh (f.o.b. Ga.), ton.	6.00 - 8.00	6.00 - 8.00	7.50 -11.00

Industrial Notes

TURBO MIXER CORP., New York, has appointed James F. Olsen sales manager to succeed Gordon MacLean who has resigned to become technical director of Allied Molasses Corp.

WICKWIRE SPENCER STEEL CO., New York, has placed Carl I. Collins on its board of directors and has named him executive vice-president. Gordon L. Crawford has been transferred from Buffalo to New York where he will act as assistant general sales manager.

THE DEVOE & RAYNOLDS CO., New York, has appointed William J. O'Callaghan sales manager of the marine division to succeed the late Harry C. Snedd.

FOSTER D. SNELL, INC., Brooklyn, N. Y. in addition to large expansion in its laboratory space last year, announces that a new laboratory will be established at some point outside New York to be devoted solely to furniture and furniture finishes.

MANNING, MAXWELL & MOORE, INC., Bridgeport, Conn., has been liquidating its railway and mill supplies division at Jersey City, N. J.

ELLIOTT COMPANY, Jeannette, Pa., recently appointed J. F. Brisse production manager for the three plants of the company.

VICTOR CHEMICAL CO., Chicago, has elected J. H. Parson of Pasadena, Calif. to its board of directors to succeed D. H. Read resigned.

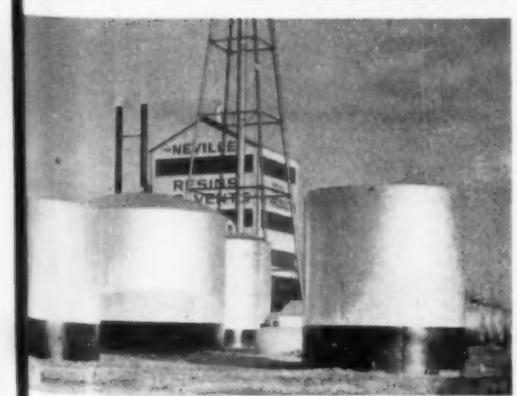
RIDBO LABORATORIES, INC., Paterson, N. J., are now located in new quarters at 111 Pennsylvania Ave.

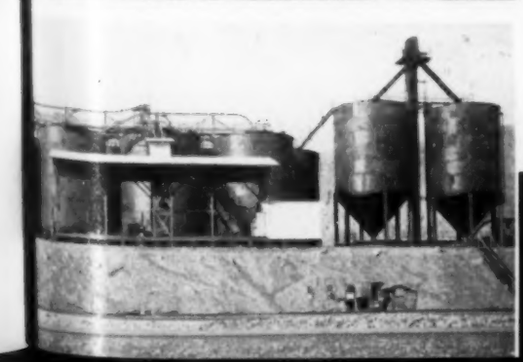
THE LINCOLN ELECTRIC CO., Cleveland, has announced new addresses for six of its offices —Oklahoma City, 19 North Ellison St.; Milwaukee, 733 North Van Buren St.; Chattanooga, 1111 James Bldg.; Chicago, 323 East 23d St.; Dayton, 246 Wiltshire Blvd.; and the Omaha representative, Fuchs Machinery & Supply Co. to 521 South 15th St.

AMERICAN LOCOMOTIVE CO., New York, announces that W. E. Corrigan, vice-president in charge of munitions and miscellaneous sales, has assumed additional duties as head of diesel engine sales.

THE CONTINENTAL CAN CO., New York, has transferred R. L. Perin from Cincinnati to San Francisco where he will act as sales manager to succeed the late C. H. Englar.

MINNESOTA LINSEED OIL CO., Minneapolis, has appointed Frank J. Tolford sales director for the Chicago territory with headquarters in the Engineering Bldg.





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NEW YORK, ROOM 990, 270 BROADWAY · CHICAGO, 1207 FIRST NATIONAL BANK BUILDING
DALLAS, 1216 PRAETORIAN BUILDING · SAN FRANCISCO, 606 RIALTO BUILDING

CHEM & MET NEW CONSTRUCTION

	Current Projects		Cumulative 1942	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	.....	$45,000	$2,550,000	$280,000
Middle Atlantic	$3,040,000	5,410,000	5,441,000	40,428,000
South	.....	7,085,000	3,305,000	24,168,000
Middle West	265,000	880,000	28,545,000	18,590,000
West of Mississippi	30,665,000	24,390,000	70,637,000	85,100,000
Far West	40,000	3,160,000	4,935,000	72,581,000
Canada	270,000	1,470,000	5,082,000	1,470,000
	$34,280,000	$42,420,000	$120,495,000	$242,617,000

PROPOSED WORK

Calif., Stockton—Pacific Pumice Materials Co., c/o Chamber of Commerce, Stockton, Calif., plans to construct a plant for processing pumice stone. Estimated cost $40,000.

Ill., Chicago—Procter & Gamble Co., 1232 West North St., Chicago, plans to rebuild 3 story plant at 1265 West North Ave. and lease same to Central Paper Stock Co. Estimated cost $150,000.

Minnesota—U. S. Government, Wash., D. C., plans to construct a processing plant. Estimated cost $21,000,000.

O., Alliance—Hawaiian Potteries, Inc., plans to construct a pottery plant, also a 125 ft. tunnel kiln. Estimated cost $40,000.

O., Cleveland—Burdett Oxygen Co., W. H. Loveman, Pres., 3300 Lakeside Ave., plans to construct an addition to its factory. H. M. Morse Co., 1500 East Superior Ave., Engrs. Estimated cost $75,000.

Pa., Gettysburg—Central Chemical Corp. of Pennsylvania, S. G. Spangler, Mgr., Gettysburg, plans to rebuild its 2 and 3 story, 55x250 ft plant recently destroyed by fire. Estimated cost will exceed $40,000.

Pa., Oil City—Wolverine Empire Refining Co., 51 Madison Ave., New York, N. Y., plans to construct an oil refinery. Estimated cost including equipment $3,000,000.

South Dakota—U. S. Government, Wash., D. C., plans to construct a processing plant. Estimated cost $800,000.

Texas—Gulf Plains Corp., Corpus Christi, plans to construct and equip a refinery. Estimated cost $3,000,000.

Texas—Pontiac Oil Co., Corpus Christi, will soon receive bids for the construction of a refinery. Estimated cost $2,500,000.

Texas—Pure Oil Co., Chicago, Ill., will soon receive bids for the construction of a refinery. Estimated cost $3,000,000.

Tex., Brownsville—Woburn Industries, c/o M. D. L. Van Over, Pres., Brownsville, plans to construct an addition to its castor bean oil manufacturing plant. Estimated cost $100,000.

Tex., Houston—General Printing Ink Corp., 100 Sixth Ave., New York, N. Y., plans to construct an ink manufacturing plant at Englewood Ry. yards on Homestead Rd. Estimated cost $225,000.

Tex., Houston—D. W. Haering & Co., Inc., Chicago, Ill., will soon award the contract for the construction of a corrosion plant. A. C. Flinn, Bankers Mortgage Bldg., Archt. Estimated cost $40,000.

B. C., Victoria—Summit Lime Works, Ltd., Box 273, Lethbridge, plans to construct a gysum and barites plant here. Estimated cost $40,000.

Man., Pointe du Bois—Lithium Corp. of Canada, Ltd., 403 Avenue Bldg., Winnipeg, Man., contemplates the construction of a salt plant. Estimated cost $40,000.

Que., Montreal—Shell Oil Co. of Canada, Ltd., 660 Ste. Catherine St., W., plans to construct an addition to its plant. Estimated cost $100,000.

Que., Waterloo—International Flare & Signal Co., Ltd., 7 Warden Rd., plans to construct an addition to its plant. Estimated cost $40,000.

Sask., Horison—D. C. Hart, Regina, Sask., plans to construct a sodium sulphate plant. Estimated cost $50,000.

CONTRACTS AWARDED

Ala., Fairfield—Tennessee Coal, Iron & R. R. Co. has awarded the contract for 73 Koppers-Becker coke ovens to Koppers Co., Koppers Bldg., Pittsburgh, Pa. Estimated cost $7,000,000.

Arkansas—U. S. Government, Wash., D. C., has awarded the contract for the construction of a chemical plant to H. B. Deal & Co., Inc., 1218 Olive St., St. Louis. Estimated cost $23,000,000.

Calif., Trona—American Potash & Chemical Co., 609 South Grand Ave., Los Angeles, has awarded the contract for an addition to its plant to United Engineers & Constructors, 816 West 5th St., Los Angeles. Estimated cost $1,000,000.

Md., Relay—Joseph E. Seagram & Sons Co., Seventh St. Rd., Louisville, Ky., has awarded the contract for an additional story to its 1 story, 74x80 ft. bottling house here to Cogswell Construction Co., 513 Park Ave., Baltimore. Estimated cost $45,000.

N. J., Bound Brook—Calco Chemical Corp., Bound Brook Rd., has awarded the contract for a 2 story, 60x400 ft. plant to E. D. Cristofer, Bound Brook. Estimated cost $160,000.

N. J., Clifton—Eastern Corrugated Container Co., 86 34th St., Brooklyn, N. Y., has awarded the contract for a 1 story, 50x60 ft. addition, also alterations to its manufacturing plant on Clifton Blvd., to C. A. Hunt Engineering Co., 485 Fort Lee Rd., Teaneck. Estimated cost $50,000.

N. J., Fords—Heyden Chemical Co., Meadow Rd., has awarded the contract for a 2 story, 30x120 ft. factory to Michael Riesz, 871 King George Rd. Estimated cost $40,000.

New York—War Dept., Wash., D. C., has awarded the contract for a plant near the New York Ordnance Works to Lummus Co., 120 Lexington Ave., New York, N. Y. Estimated cost will exceed $5,000,000.

N. C., Pisgah Forest—Ecusta Paper Corp., Pisgah Forest, has awarded the contract for the construction of a storage building to Fiske-Carter Construction Co., Greenville, S. C. Estimated cost between $50,000 and $75,000.

Ohio—Goodyear Tire & Rubber Co., 1144 East Market St., Akron, O., has awarded the contract for the construction of a plant to Indiana Engineering & Construction Co., 109 North Union St., Akron. Estimated cost $750,000.

O., Cleveland—Standard Oil Co., A. B. Carmitchel in charge, Midland Bldg., has awarded the contract for 98x135 ft. and 22x128 ft. plants to H. K. Ferguson Co., Hanna Bldg. Estimated cost $50,000.

Ore., Portland—Galvanizers, Inc., 2406 N. W. 30th St., has awarded the contract for a 1 story, 75x150 ft. and 75x135 ft. factory buildings to A. J. Bingham & Son, Couch Bldg. Estimated cost $160,000.

Pa., Mertztown—Atlas Mineral Products Co. will construct addition to its plant here including laboratory and office building. Work will be done by separate contracts. Estimated cost will exceed $40,000.

Pa., Midland—Air Reduction Sales Corp., H. VanFleet, Vice Pres., 60 East 42nd St., New York, N. Y., has awarded the contract for alterations and additions to its plant here to E. T. Machine Co., Commonwealth Bldg., 512 Hamilton St., Allentown. Estimated cost $75,000.

R. I., Ashton—Owen-Corning Fiber Glass Co., Ashton, has awarded the contract for a 2 story addition to its plant to Central Engineering & Construction Co., 210 Main St., Pawtucket. Estimated cost $45,000.

Texas—Phillips Petroleum Co., Borger, Tex., and Tulsa, Okla., will construct a refinery. Work will be done by subcontracts and force account. Estimated cost $650,000.

Texas—Humble Oil & Refining Co., Baytown, has awarded the contract for a 2 story, 77x102 ft. paint manufacturing plant to Southwestern Construction Co., Houston. Estimated cost $100,000.

Texas—Texas Co., Port Arthur, will construct a refinery. Work will be done by subcontracts and force account. Estimated cost $600,000.

Tex., Houston—Earl North, Travis and Webster Sts., will construct and equip a chemical manufacturing plant. Work will be done by owner. Estimated cost $40,000.

Utah—Karmite, Inc., Salt Lake City, has awarded the contract for the construction of a plant to Leonard Construction Co., Chicago, Ill. Estimated cost $2,000,000.

Wis., Milwaukee—Milwaukee Lace Paper Co., 1306 East Meinecke Ave., has awarded contracts for 1 story, 70x120 ft. factory addition to Scholtka Bros., 3600 West Silver Springs Dr. and Charles Salb Construction Co., 2045 North 4th St.

Wis., Rothschild—Marathon Paper Mills Co., Rothschild, has awarded the contract for a 1 story, 32x80 ft. addition to its plant to Permanent Construction Co., West Capitol and North Third Sts., Milwaukee, Wis.

Ont., Haley Station—Dominion Magnesium, Ltd., National Bank Bldg., Ottawa, has awarded the contract for the construction of a briquette plant to Foundation Co. of Ontario, Ltd., 1158 Bay St., Toronto. Estimated cost $320,000.

Que., Montreal—Commercial Alcohols, Ltd., 3176 Notre Dame St., E., has awarded the contract for a 1 story, 70x100 ft. plant to Sutherland Construction Co., Ltd., 1440 St. Catherine St., W., Montreal. Estimated cost $150,000.

Que., Shawinigan Falls—Aluminum Co. of Canada, Ltd., Sun Life Bldg., Montreal, has awarded the contract for four additional pot rooms at its plant to Fraser-Brace Engineering Co., Ltd., 360 St. James St., W., Montreal. Estimated cost $1,000,000.